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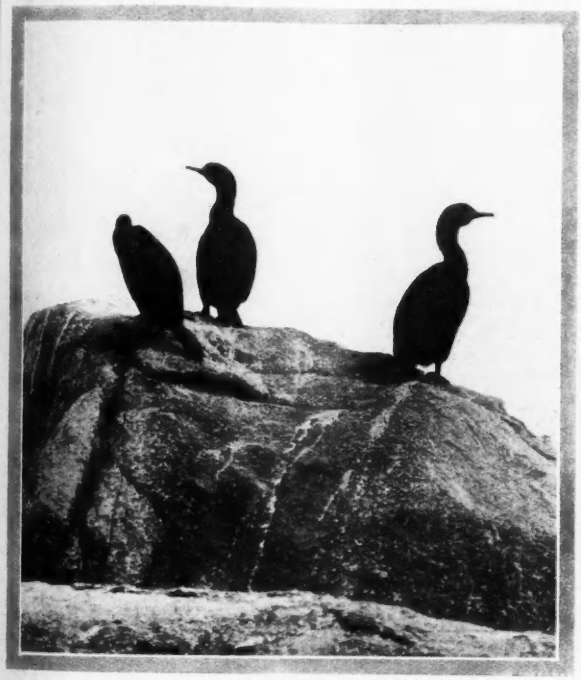
ALL ABOUT RADIUM

DISCOVERY

A Monthly Popular Journal of Knowledge

Vol. X. No. 115. JULY, 1929. PRICE 1s. NET



DEEP SEA ANGLERS.
Group of Shags, or Green Cormorants.

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Editorial Notes.

The first six months of 1929, so far as science and the public are concerned, will go down to history as the period in which the "talking film" was introduced and developed in England. The invention has, of course, been employed extensively for some time in the United States, but in crossing the Atlantic it seems to have acquired increased glamour, so that the "talkie" has caught the popular imagination to an unusual degree. On their first day of office, the new Labour Cabinet posed for a talking film at No. 10, Downing Street. Their action may be criticized as out of keeping with the dignity of Government, but there is no doubt that it gave much publicity to this invention. Notwithstanding the growing number of educational films—the cynic might almost say because of them, they are often so very dull—public interest in the silent cinema has tended to decline of late years. A contributor to our columns recently prophesied that sound would affect adversely what he called the legitimate cinema, and we supported his view in recognizing this as a probable effect. The last few months, however, have afforded actual experience which suggests that, if intelligent advantage is taken of the present situation, the cinema as a whole may gain a new and more vigorous lease of life than ever before. Attempts hitherto to screen famous literature, for example certain of Shakespeare's plays, have naturally lacked any serious appeal in the absence of the spoken word. Now, provided plays suited to the films are chosen and that the actors employed can speak the King's English, a unique method of educational propaganda becomes available. Already the "Taming of the Shrew" has been filmed with voice accompaniment, and there are signs that the English producers, at any rate, will turn more and more to classic authors for their material.

* * * * *

While sound is regarded in connexion with films as their younger relative, another development is occurring which reverses this relationship. The gramophone has long been used for recording lectures, but in the absence of visual expression and gesture the effect of many speeches is seriously handicapped. Similarly, pictures of a speaker without his words are apt to be frankly comic; in reproducing lectures, therefore, the "talkie" has a most promising future. When the transatlantic telephone service opened in January, 1927, the publishers of *Discovery* were among the first to make use of it. Now we are able to record an interesting event relating to the newer invention. As proprietor of our associated journal the *Electrician*, Sir Ernest Benn was invited to attend and to address a congress of electrical engineers at Atlantic City. On his refusing (a visit to America proving impossible), the organizers invited him to afford them a talking film, which was accordingly made at a country house in Surrey. Three weeks later a cable arrived from the congress, where, three thousand miles away, Sir Ernest had been clearly seen and heard by an appreciative audience of over 6,000 people. The film had been dispatched from England undeveloped, and until this word was received the speaker himself had no idea whether the experiment had been successful.

* * * * *

During the past few days the Centenary of King's College, London, was celebrated, the proceedings being opened on 26th June by the Duke and Duchess of York. For a hundred years this College has trained men who have distinguished themselves in all walks of life. Such names in science as Wheatstone, the inventor of the electric telegraph, Daniell, the chemist,

and Hopkinson, the inventor of the three wire system ; in literature, Thomas Hardy, and in medicine, Lord Lister, the founder of antiseptic surgery, justify the College in being proud of its record. To-day its contributions to education and trade are no less remarkable, as illustrating which it may be noted that the head of the Physics Department, Professor E. V. Appleton, has just been awarded the Morris Liebmann Memorial Prize for 1929 by the American Institute of Radio Engineers. This prize is awarded annually to the worker responsible for the most important contribution made to wireless progress during the preceding year. Professor Appleton is well known for his researches on the causes of wireless signal fading, and for his experimental evidence on the existence of the Heaviside Layer. It would be no exaggeration to say that the research into wireless methods developed at King's College has contributed more to our knowledge of the electrical properties of the upper atmosphere than any other source. All this work, however, is being carried on under the gravest financial difficulties. The endowment capital produces only £4,800 a year towards a necessary expenditure of £130,000. The authorities depend almost entirely upon a fluctuating fee income, and it is not often realized that no student covers the entire cost of his education. To mark the Centenary an appeal is made for £350,000 which is required to establish chairs in electrical engineering and other faculties, and for the provision of scholarships and bursaries.

* * * * *

We shall publish shortly an account of the conference on the Safety of Life at Sea, which has just been sitting in London. Every year increasing research is devoted to safety appliances, and one of the gravest dangers to naval craft—the accidental sinking of submarines—is the subject of a new invention appropriately made public last month. A test was held in the deep waters of Loch Long, Dumbartonshire, where it is claimed that a new world's record in diving was established. As reported in *The Times*, both appliances were submitted to the Admiralty by Siebe, Gorman, and Co., and tested on board the naval diving ship "Tedmouth." The apparatus for the use of submarine crews weighs less than five lbs. It is strapped on the man's chest, and has a flexible tube with a mouthpiece through which he breathes, the air exhaled into the apparatus being regenerated by the absorption of the carbon monoxide. During the test, the men were sunk in a chamber to a depth of twenty-one fathoms. Wearing the apparatus, they quitted the chamber at this depth, and in each instance reached the surface safely in a minute and a quarter. The second device which has so greatly increased the depth that divers in flexible dress can reach is the outcome of experiments carried out over a period of years by Mr. R. H. Davis, the head of the firm, and Professor Leonard Hill, the well-known physiologist. A diver equipped with the ordinary apparatus is subjected to pressure which varies with the depth, and so has to be raised gradually to the surface. This long "decompression" period is very severe, for it may last for over an hour. With the idea of shortening the period a submersible decompression chamber has been invented. The diver enters it under the water, and this device, in conjunction with apparatus which supplies oxygen in the chamber, allows descent to much greater depths than before.

* * * * *

Steady progress has been made in the past few months with the Fultograph system of picture transmission by wireless and telephone line. Every day, except Sunday, news pictures are transmitted by the B.B.C. from 5XX and 2LO or 5GB. In addition, a service is being broadcast from Berlin and Vienna, and it is probable that Paris will begin very shortly. An interesting experiment last month was the reception of pictures of the Derby by wireless on board the "Flying Scotsman" during its journey from London to Edinburgh, and simultaneously on the down train from Edinburgh to London. To realize the difficulty of this achievement, it must be pointed out that the train was travelling sixty miles per hour, and was just entering Edinburgh at the time of the picture reception—nearly three hundred miles from Daventry.

* * * * *

Future arrangements have just been announced for the wireless transmission of weather maps, in conjunction with the Meteorological Office and the Air Ministry. The map will be broadcast from 5XX between 2 p.m. and 2.25 p.m. on Tuesdays and Thursdays. Many people are already familiar with weather maps through their regular publication in the newspapers. The great difficulty in the past has always been to get weather maps delivered quickly enough for practical use to be made of them. Wireless transmissions will overcome this difficulty, and though during the experimental period the 7 a.m. weather map will not be broadcast before 2 p.m., it may be possible later to arrange for an earlier hour. With regard to the distinct and much more difficult problem of television, it appears that the Baird Company is working quietly to improve its apparatus, following the refusal for the time being of official co-operation.

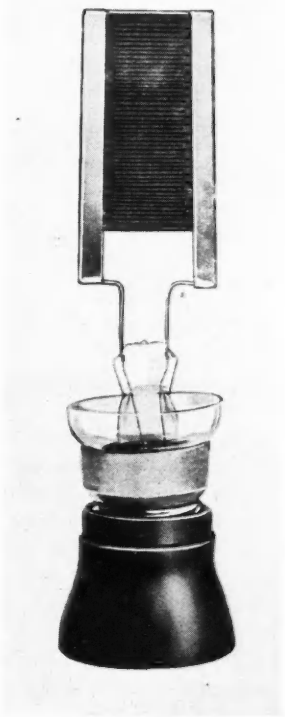
Selenium the Modern Slave.

By L. V. Dodds.

Selenium has the valuable property of reacting to light, but only recently have important uses been discovered for this remarkable material. It has already replaced the street lamp lighter in one London district, while the railways are investigating its application to automatic train control.

THE peculiar property of selenium is that its electrical resistance varies according to the intensity of light impinging upon it. This simple fact has been known to physicists for well over fifty years, but inability to make a selenium cell capable of withstanding ordinary commercial voltages has prevented its application to many technical problems. The intensive research on television is not here discussed, but in other processes success has recently been achieved. It is now possible to construct a selenium cell not only capable of withstanding ordinary voltages, but which will function efficiently at voltages ranging from 12 to 1,000. There is enormous scope for the application of this discovery, which is the work of a British scientist, and some of the ways in which it is being used now are of great interest.

The new selenium cell, or bridge, as it is called, consists of a piece of acid glass on which a number of lines have been formed with a solution of liquid gold. These lines are drawn so as to form two combs arranged like the plates of a condenser, and they are completely separated from one another. After these line-electrodes are made, they are fused into the glass by firing at a temperature of 325° C., and the process is repeated until the lines of gold metal have the required conductance. Then the glass plate is heated to a temperature of about 200° C. and the metallic lines and spaces between them are thinly coated with selenium, which is afterwards annealed. Seasoning is done by the usual methods, and the bridge is mounted in a glass envelope similar to that of a thermionic valve, and wired like an ordinary incandescent lamp. The current required to influence the bridge is almost negligible, being measured in micro-amperes, and its life is at present indefinite. Bridges have been on test constantly for almost two years without deterioration being detected, and it is claimed that there is no obvious reason why they should not be permanently effective. In case of damage, however, bridges can be easily and quickly replaced at a cost of a few shillings.



SELENIUM BRIDGE.

This view of an unmounted bridge shows constructional details, including the gold lines on the central strip of acid glass.

Working in conjunction with the selenium bridge is a sensitive, polarized relay switch, which has been specially designed to operate under the very minute current passed by the bridge. Briefly, therefore, the application of the process is, that any alteration in the intensity of the light received by the selenium bridge varies its electrical resistance, and this current causes the relay mechanism to operate the switches of the apparatus which it controls. The bridge is so sensitive that the very slightest variation is amply sufficient for the purpose.

The new cell has been applied already to many commercial problems, and one of the most interesting is the control of street lighting. Under the direction of Mr. C. S. Davidson, chief engineer to the electricity department of the Barnes Urban District Council, this system was installed in Sheen Common Drive about a year ago and is still working efficiently. The bridge and relay are mounted in a metal case and fitted to the ordinary street lamps and are operated solely by the daylight received. Suitable arrangements enable the relay to be set so that it will operate at any predetermined degree of darkness. At dusk the decreasing daylight influences the selenium bridge which causes the relay mechanism to switch on the lamp, while in the morning the increasing daylight causes it to be extinguished. One point of value about this method is that it acts perfectly well in foggy weather, the

street lamps being lit and put out as the fog thickens and lifts. Train lighting can be worked similarly, and the L.N.E.R. are stated to be investigating the method. The carriage lights appear when the train enters a tunnel and go out immediately daylight is reached at the other end.

In connexion with lighting, another use is the fitting of selenium bridges at various points in the supply area of an electric power station to give warning of approaching fog. For this system, the indicator in the power station is a micro-ammeter connected permanently in series with each of the bridges, the readings of the instrument giving a continuous indication of the light intensity at the point where the bridge is situated. Should the light intensity fall below a certain pre-determined value, both a visible and audible signal is given so that the necessary preparations for an increase in load can be made at the power station.

NEW STREET LAMP.

As now used at Barnes, this street lamp is automatically switched on and off by the daylight working the selenium device fitted in the cowl (here seen in section).

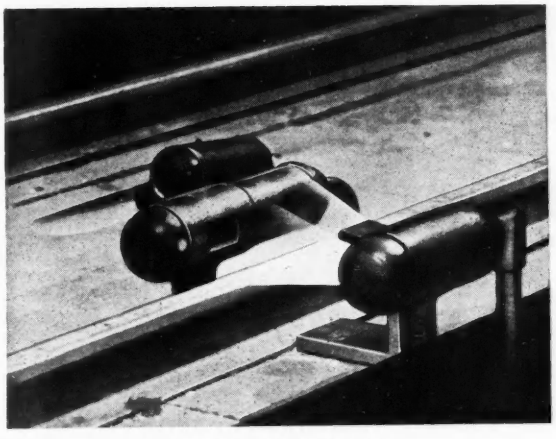
Another of the ingenious uses to which the selenium bridge is applied is that of operating a burglar alarm. The cell is so sensitive to light that the infra-red rays alone are sufficient to influence it, and, consequently, as these rays are invisible, a very clever method of crime prevention becomes possible. In this device, the relay operates an alarm bell and the rays are provided by an ordinary filament lamp which is fitted with a suitable filter to eliminate all the visible light. To prevent access to a safe, an important firm of bullion merchants have fitted a selenium bridge to one side of a room and the lamp on the other, so that the invisible beam makes a circuit in front of the safe. In this instance there is no other method of approach. Any person crossing the path of the rays, or even interposing a hand, is sufficient to break the circuit and set the alarm bell ringing outside the building, thereby warning both police and night watchman that something is amiss, and the bell continues to ring until it is switched off independently. Any interference with either bridge or lamp would break the circuit similarly and so give the alarm.

A large jewellery establishment has another interesting safety device. A selenium bridge is concealed amongst the window dressing, and the relay controls the light switches of the building. This alarm is operated by the policeman on beat outside, who has been shown previously where the bridge is placed. By flashing his torch directly on it, the whole floor is immediately illuminated and he is able to see if all is correct. When his torch is switched off, the lights go out too, and the cell is so situated that it will only operate on a direct beam of light, so that chance interference by unauthorized persons is practically impossible.

Another application of considerable importance is in connexion with railway working, and in this development all the four British railway companies are keenly interested. For this purpose, the permanent way is regarded as being divided into a number of sections, the requirements being that it shall be impossible for more than one train to run on the same section of track at the same time. A lamp and bridge are situated at the commencement of each track section in such a way that the passage of a train breaks the light beam and so causes the relay to operate the signal situated at the beginning of the previous section, thus indicating to a following train that the section ahead is blocked. When the train has completed that section the signal is reverted to normal under the action of the next relay. The relays for each section of track are interconnected by a single trip wire in such a manner that on the first train proceeding on to the section ahead, it will automatically release the first relay

and signal, and allow the following train to proceed.

A similar device also enables a train to be stopped automatically. This involves fitting a selenium bridge on the engine, and a lamp on the permanent way. At signal points a vertical plate is fitted to the track in such a position that it passes between the lamp and the bridge on the engine, so breaking the circuit. If, however, the signal is at the "off" position, a second lamp in the track supplies the missing light to the selenium bridge on the locomotive and so allows the train to proceed. Should the signal be at danger and the driver over-runs his signal, the second lamp is not illuminated and so the circuit is broken. Thereupon the relay on the engine operates a trip mechanism, so that the air-braking mechanism is tripped similarly and the train brought to a standstill. Both an audible and visible signal give warning to the driver in his cab, and it is claimed that this method renders accidents due to failure of the human element impossible. Should the apparatus break down in any way, again the circuit is broken and a warning given to the junction and termini. For electric traction, a section of the line can be made dead by the operation of the train stop lamp and a suitable circuit-breaker.



RAILWAY SAFETY DEVICE.

The selenium equipment is fitted either side of the lines and automatic train control is effected by the engine, passing between the two parts of the bridge.

The great simplicity of working is one of the advantages claimed for the method, and the low cost of installation and maintainance are greatly in its favour. The current consumption is small and the necessary supply can be obtained by wires fed from the existing telegraph poles. The efficiency of the apparatus is unaffected by fog, for then the bridge is influenced by the invisible infra-red rays, and as failure at any point is notified immediately, there is no doubt that the system is one of great commercial possibility. The Great Western Railway have tested this apparatus recently on a section of line, and very satisfactory results were obtained.

The safety of ships at sea will benefit considerably from a method of using a selenium bridge for detecting fire in the hold, and this can be applied also in factories where warehouses are situated at considerable distance from a central office. In this instrument the selenium bridge is enclosed in a metal cylinder with an outlet on top resembling a small chimney. This cylinder is connected to another, containing the lamp, by means of an inclined tube through which the light rays pass from the lamp to the bridge. This second cylinder is open at the bottom through which the air set in motion by the heat of the lamp enters. This air current passes through the connecting duct and escapes from the chimney at the top of the bridge cylinder. In the event of fire, smoke will be drawn through this tube similarly and this will interfere sufficiently with the light rays to cause the relay to operate, giving audible and visible signals on the bridge of the ship, or at any other convenient point. A similar alarm would be given, of course, if the apparatus failed in any part, but means are provided whereby it is possible to determine at once whether the alarm is due to an actual fire or a breakdown of the apparatus. The Adelaide Steamship Company are adopting this method, and many others are investigating its possibilities, so that when further tests are completed the system should be used extensively.

The application of the selenium bridge to technical processes is still relatively new, and while some of the present applications are astounding in their ingenuity and simplicity of working, it is undoubted that further research will evolve other uses even more spectacular. In the laboratories of the Radiovisor Parent, Ltd., the makers of this light sensitive apparatus, tests are now being made on a device for the magnification of sound without amplification, and, consequently, without distortion, and this alone will produce a whole series of important developments when success is attained. More than fifty years research has been necessary to produce a selenium cell capable of being generally applied, and the results achieved so far indicate clearly the great importance and value of the discovery.

The "Next Step."—VII.

The Future of Radiology.

By V. E. Pullin.

Director of Radiological Research, Woolwich Arsenal.

In view of the successful public appeal to provide radium for British hospitals, this month's article on the future of radiology has much topical interest. But the science is by no means confined to medicine, and the "death ray" of fiction may even yet become an accomplished fact.

THE Editor has demanded an article upon the future of radiology. The title is a little awe-inspiring, and it would be a bold man who would venture fully to satisfy it. There are, however, certain definite lines upon which the subject must develop immediately, and they involve many different activities. Strictly speaking, the term "radiology" is very wide. It embraces such diverse phenomena as the wireless transmission of words and pictures, the treatment of cancer by radium, and the examination of heavy engineering castings by X-rays; not to mention the radiation of heat and all kinds of illumination.

The particular sort of waves which are involved in all these manifestations are called "electro-magnetic," and they vary not in kind but in quality. They range from a numerical frequency of impulse which is very low as in the case of wireless "rays," to the very high frequencies indeed which are characteristic of penetrating X-rays and the "gamma" rays of radium. The complete table of these frequencies is usually referred to as the electro-magnetic spectrum (Fig. 1.)

The beginning of the science of radiology is traceable to the discovery of the composition of white light by Sir Isaac Newton more than two hundred years ago. Since then new types of radiation have been discovered from time to time, which has resulted in the very considerable knowledge now available concerning the various constituents of the total spectrum as we know it. Sir Isaac Newton believed that light was composed of tiny corpuscles. It was the scientists Young, Fresnel, and Clerk-Maxwell who developed the modern wave theory, and showed that light was a disturbance of the ether and that the various colours were due to the different rates of disturbance. Different qualities or colours of light are usually referred to as having different wave-lengths. Subsequently other similar wave motions were discovered, and proved to have the same nature as light, but having wave-lengths such that they fell outside the visible portion of the spectrum. For example, in 1895, Professor Röntgen discovered X-rays which had the curious property of being able to penetrate normally opaque substances. Although the nature of X-rays was not established for many years after their discovery, yet they were ultimately proved (in 1911), to be the same as visible light, but having a wave-length some ten thousand times shorter. About a year after Röntgen's discovery, Henri Becquerel found that a certain substance—uranium—spontaneously emitted radiation, similar in many respects to X-rays. Subsequently, the brilliant work of Monsieur and Madame Curie isolated the element radium which spontaneously yields radiation similar to X-rays, but having an infinitely shorter wave-length.

At the other end of the visible spectrum are heat waves having a much longer wave-length than visible light, and beyond these rays again the longer waves which are used in wireless transmission.

With regard, first, to the "radiology" of long waves, the chief future development will be in the transmission of speech and picture, but these matters are outside the scope of this article. At the same time, there is one very significant step recently accomplished, which may have important consequences. By the use

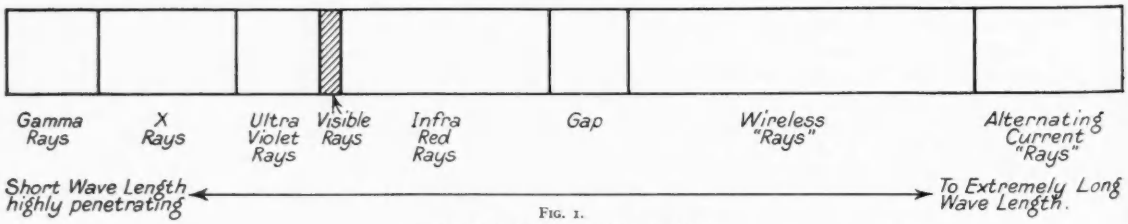


FIG. 1.

THE ELECTRO-MAGNETIC SPECTRUM.

It will be seen what a relatively small amount of the total spectrum is occupied by visible rays.

of invisible infra-red rays, that is, the invisible heat-rays just adjacent to the visible spectrum, pictures have been transmitted when the subject is enveloped in darkness. It is, perhaps, not unduly optimistic to forecast that the time will come when these invisible rays may be projected over great distances and by means of suitable electric recorders, a perfect image of a distant scene may be reproduced although the subject may be entirely unaware of the event.

Consideration of the invisible waves close to the visible spectrum suggests a remark on the now popular ultra-violet rays. These rays are invisible, and as will be seen by a reference to Fig. 1, they lie between the visible rays and X-rays. The curative properties of this radiation has received much emphasis during the past few years, and there is no doubt that in certain conditions, these rays are most beneficial when applied under skilled direction. It is probable that they are the component in ordinary sunlight which confers its health-giving properties. At the same time, a word of warning may not be out of place. Artificial sunlight may very easily be overdone, as, indeed, may natural sunlight which in excess brings evils of its own. The localized and indiscriminate application of artificial sunlight by means of lamps may easily do positive harm, and it is questionable whether it should ever be employed without medical advice. On the other hand, it would certainly be wise to take every advantage of natural sunlight by allowing the beneficial ultra-violet rays to enter our buildings. Ordinary glass effectively stops all these rays. Quartz glass, on the other hand, allows them to pass, and it is probable that in the future all buildings will be glazed with this desirable and truly transparent substance.

FIG. 2.
3.4 GRAMS OF RADIUM.
This photograph was taken by the radiation emitted from the radium. Reproduced by courtesy of Messrs. Watson & Co. (Electro-Medical).

The great discovery of X-rays was made only a little over thirty years ago, and already X-rays are one of the prime necessities in modern civilization. Their chief use has proved to be in diagnostic medicine and surgery, and they have also considerable value in the treatment of disease. Of late years, however, their use has extended into industry, and nowadays they are used extensively in the examination of important industrial materials required for all classes of work, from the building of battleships and aeroplanes to the examination of golf balls. X-rays are generated by the application of very high voltages to the terminals of a vacuum tube, and the penetrating power of the rays depends upon the voltage so applied. An X-ray tube is really a two electrode valve. In medical and surgical diagnosis the voltage is usually of the order of 100,000, but in heavy engineering work the higher the voltage the more useful are the rays. Voltages of about 250,000 are commonly employed, and these very high voltages are also necessary when X-rays are used for therapeutic purposes. So far this voltage for X-ray work has not been exceeded in any practical manner. Certainly the industrial use of the rays will be much more valuable when scientific research has made it possible to operate X-ray tubes at, say, 500,000 volts. This development may confidently be expected at no very distant date, in fact, an experimental X-ray tube has already been constructed in America to operate at 750,000 volts. The work is only yet in an experimental stage, but the results are very striking.* It should soon be possible, therefore, to examine steel castings and forgings for flaws up to eight inches or so in thickness. It is obvious that large savings would be effected by the discovery of faults in such material before expensive machining had been done on it. Such voltages, too, would doubtless have great value in X-ray therapy, although it seems probable that X-rays for this purpose will, to a very large extent in the future, be superseded by radium, of which we shall have something to say a little later on.

One of the most important uses of X-rays is due to their ability to yield fundamental information concerning the manner in which the atoms are arranged in crystalline substances. The arrangement of the constituent atoms confers all the properties that

* Lauritsen and Bennett. *Physical Review*, Vol. 32, No. 6, pp. 850-857.

characterize any material. Hardness, brittleness, elasticity, lubricating power, and so on, all depend upon atomic arrangement. Atoms are usually separated from each other in solid materials by about one X-ray wave-length, consequently we may employ this form of illumination to investigate atomic structure. This work, although it has progressed enormously during the past few years, is really only in its infancy; but it is safe to predict that X-rays will provide the universal "atom microscope" of the future. The optical microscope has even now reached the limit of its power, and its work will in future be extended into the realm of atoms by an instrument known as the X-ray Spectrometer which we owe to Sir William Bragg.

Turning now to radium itself, the curative power of radium radiation was recognized in about 1900, and great hopes were entertained that it would prove to be a universal cure for cancer. This early view was unduly optimistic, and later results did not justify the initial enthusiasm. As research in the subject proceeded, however, it was found that improved technique went far to revive the early belief. It is now generally conceded that radium is one of the most potent agents in the treatment of cancer. One of its most striking properties is its selective action on diseased cells which are destroyed by it in preference to the surrounding healthy tissue. Radium is a very curious element in that it is constantly disintegrating and in doing so it gives rise to three different types of radiation. Two of them known as the *alpha* and *beta* radiations, are really streams of minute particles; the third, or the *gamma* radiation—which is used in cancer therapy—is precisely similar to light and X-rays, except that its wave-length is very much shorter.

Cancer Treatment.

Radium is produced by a very complicated and expensive chemical process from certain ores which are found in various parts of the world. The chief source of present supply is the Belgian Congo. The present high price of radium (about £12,000 a gram) is due entirely to the difficult process of extraction from the ore, and it must not be thought for a moment that supplies are insufficient for the world's needs. It is estimated that England, Scotland and Wales need about twenty grams for the adequate treatment of disease, the cost of which will be about a quarter of a million pounds. This sum, urgently required to provide an imperative necessity for the welfare of a great nation, is happily now available. There is no doubt whatever about the value of radium in cancer treatment, as the concensus of medical opinion is positive on the question.

Future research in the treatment of cancer by radium is largely concerned with methods of conveying the radium to the seat of the trouble, and every year fresh advances are made and more remote growths are brought within its powerful influence. Not only must the nation see to it that a sufficient quantity of radium is provided, but it must also give the fullest support financially and in every other way to those institutions where research on radium technique is being carried out. At the present time the use of radium is confined to a comparatively few highly trained specialists. The number must be increased so that no sufferer in the country need lack proper treatment.

The "Death Ray."

From time to time there have been rumours of new and potent "rays." The inventors have made picturesque and extravagant claims that these "death" rays would not only kill human beings in their path, but would disorganize and put out of action all forms of mechanical and electrical transport. So far all these claims have proved to be invalid. There is, however, no reason whatever why new and powerful forms of radiation should not be forthcoming. It is well known, for example, that there are enormous —almost incredible—quantities of energy stored up in the nuclei of atoms. The atom of radium, for example, breaks up of its own accord, and in doing so releases one of the most powerful forms of energy known to science—*gamma* radiation. Whether it will be possible to release and control atomic energy cannot be foretold; so far science has no evidence of the imminence of such a stupendous happening, but she does not postulate its impossibility. The "death ray" of romance and moving-picture fame, may even yet become an accomplished fact.

The famous American scientist, Professor Millikan, discovered, some two or three years ago, a new form of radiation which proceeds from the sun. These "cosmic" rays, as he called them, are very much more penetrating than the *gamma* rays of radium. There is no doubt about their existence, but so far they are simply the subject matter of scientific experiment.

The recognition of radiology as a specific science is comparatively new, and its future is at present unknowable. Science has shown that radiation is the fundamental force behind all physical phenomena. but scientific investigation, so far, has only penetrated into the outer fringe of the subject. It is safe to assert that its development is the basis upon which all future advances in knowledge must build.

Who Wrote the Letters of Junius?

By C. Ainsworth Mitchell, M.A., D.Sc., F.I.C.

Secretary to the Society of Public Analysts.

Two recent books have revived the controversy as to the authorship of certain political letters published at the close of the eighteenth century. Dr. Mitchell, therefore, made a scientific analysis of the handwriting, and has discovered new evidence which should finally settle the problem.

It is not easy for us who live so far removed from the times, and to whom most of the persons attacked are little more than names, to realize the sensation made by the series of anonymous letters which appeared over the pseudonym of "Junius." At the time when the first letter was published in "Woodfall's Public Advertiser" a Coalition Government, with the Duke of Grafton as Prime Minister, had been in power for two years, and was, to all intents and purposes, merely the mouthpiece of the King. As Burke pithily remarked: "The Cabinet was a tesselated pavement without cement," and consisted of "such a strange combination of King's friends and republicans, treacherous friends and open enemies" that it was unreasonable to expect it to act consistently. Abuses of privilege were rampant everywhere, political bribery was bare-faced, and the legislature was subservient to the Ministry. The King was endeavouring to govern without Parliament, and his stubborn refusal to listen to colonial grievances was leading up to the American War of Independence. On all sides there was smouldering discontent, but no one could give vent to this publicly, for the press was not free and its struggles to gain freedom were meeting with the determined resistance of the King and the governing class. Such was the state of the political world when, to quote Dr. Johnson, "Junius burst into notice with a blaze of impudence which has rarely glared upon the world before, and drew the rabble after him."

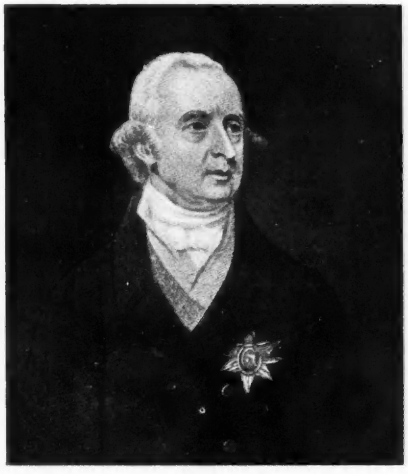


Fig. 1.
SIR PHILIP FRANCIS.
From a contemporary portrait by J. Hoppner, R.A.

His first letter (November 21st, 1768) was a caustic attack on the ineptitude and corruption of the ministry, on the administration of justice, and on the abuses in the control of the army. In subsequent letters personal attacks were made on the Prime Minister, the Duke of Bedford, and Lord Mansfield (the Chief Justice), this series culminating in an open attack upon George III himself (December 19th, 1769). The King's public conduct is stigmatized in terms such as Junius says he might have used "had it been my misfortune to live in the reign of a prince whose whole life was employed in a struggle with the free spirit of his people."

This challenge was too flagrant to be ignored, and the Attorney General filed a bill in the King's Bench against Woodfall, the publisher, since the author of the letter could not be discovered. The case was tried on June 13th, 1770, before Lord Mansfield, who directed the jury that the intention to libel was no concern of theirs, that the words "malicious" and "seditious" were formal, and that they were only to consider the fact of publishing. The jury, however, after long deliberation returned a verdict which practically amounted to an acquittal. In the forty-second letter (November 14th, 1770) Junius attacks Lord Mansfield's direction to the jury, asserting that it was inconsistent with his own practice and contrary to the best legal authority. The last published letter, also to Lord Mansfield, which appeared on January 21st, 1772, is a long, closely reasoned argument, to show that the judge had acted illegally in allowing bail in a case of felony. The knowledge of the law in this letter has some significance in considering the possible authorship of the letters. In his farewell letter to Woodfall (January 9th, 1773) Junius says that he despairs of the cause and of the public, and that he would be foolish to write any more.

Considered as a whole, the letters of Junius are forcible and have a distinctive style which in places

reaches eloquence, but they are often marred by unnecesaary cruelty. Many of the aphorisms scattered throughout the series are witty and usually cut deep. As they are characteristic of the writer two of them may be quoted. Replying to Sir William Draper, who had rashly attempted to answer some of the letters, Junius points out that his advocacy had only

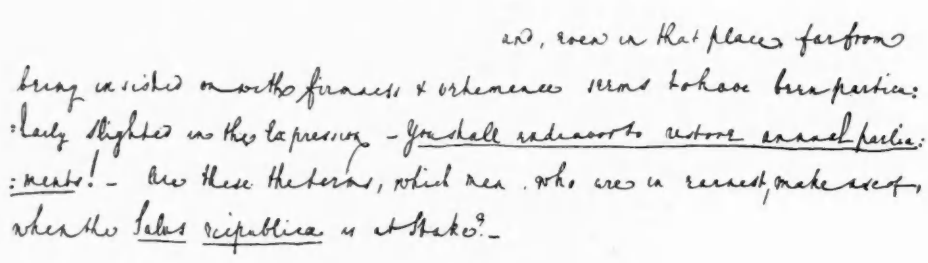


Fig. 2.

EXTRACT FROM A LETTER OF JUNIUS.

Characteristic habits in the calligraphy of Junius, seen above, include the use of a colon to indicate broken words at the end of a line, with a second colon at the beginning of the next.

done harm by bringing out points which had been overlooked, and remarks: "We say in common discourse that a man may be his own enemy . . . but that a man should be the bitterest enemy of his friends implies a contradiction of a peculiar nature." In one of his savage attacks on the Duke of Grafton (the Prime Minister) Junius observes that "the character of the reputed ancestors of some men has made it possible for their descendants to be vicious in the extreme without being degenerate."

These examples of what might almost be expanded into a book of proverbs, are sufficient to show that whoever wrote the letters had a gift of pungent sarcasm, and in themselves they are sufficient to rule out the larger proportion of those whose names have severally been put forward as the writer. The doubtful honour was attributed to at least forty-two well-known persons, including Burke, Lord George Sackville, Hugh Macaulay Boyd, and General Lee (an American). Many pamphlets for and against the claims of this or that man or woman were published, and the problem was discussed at dinner tables and in the coffee-houses to the point of boredom.

Among suspected names was that of Sir Philip Francis (1740-1818) who was of Irish origin, the son of Philip Francis, D.D. Entering the Civil Service, he became chief clerk of the War Office, and in 1774 was appointed to the Council of Bengal, where he became the chief opponent of Warren Hastings. Francis was elected M.P. for Bletching in 1781, and was knighted in 1806. (Fig. 1.) It was not until 1818, however, when it was shown by Taylor in his book on "The Identity of Junius" that there were many

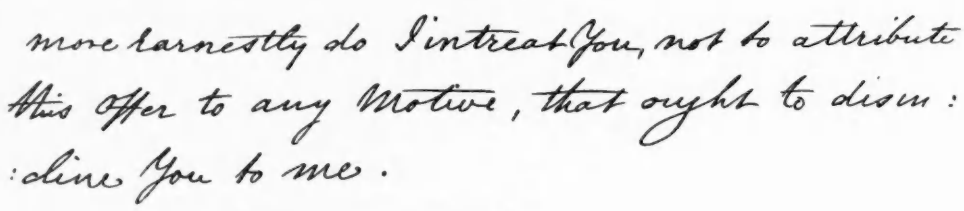


Fig. 3.

THE WRITING OF SIR PHILIP FRANCIS.

The passage here reproduced shows the same unusual practice in regard to the colon found in the letters of Junius, which has never been discovered in the writing of other supposed authors.

remarkable similarities between the writings of the letters and that of Francis, that his guilt became widely accepted. Macaulay in his essay on Warren Hastings (1841) reviewed the available evidence and was emphatic in his opinion that the evidence in favour of Francis would have been strong enough to support a verdict in a criminal trial. Moreover—and his word carries weight on this point—Macaulay did not agree that the acknowledged writings of Francis are decidely inferior

to the best of the anonymous letters, which are themselves of very unequal merit.

The evidence in support of Francis was strengthened by the publication of his "Life" by Parkes and Merivale in 1867, for these memoirs prove that in his later years, when there was less risk in the admission, Francis was willing to let it be thought that he was Junius. This disposes of the main argument, apart from the question of literary style, urged by Hayward in 1868 in his book, "More about Junius," against the claims made on behalf of Francis. No one, Hayward contends, would be so base as to attack his own benefactor, and yet, since Francis was willing to let it be thought that he wrote the letters, obviously he had no scruples about being thought capable of ingratitude. Among the numerous collateral points urged in support of Francis's authorship were his political views, his intimate acquaintance with War Office procedure, his extensive but not always exact knowledge of the law, and the fact that interruptions in the publication of the Junius letters coincided with his absence from London.

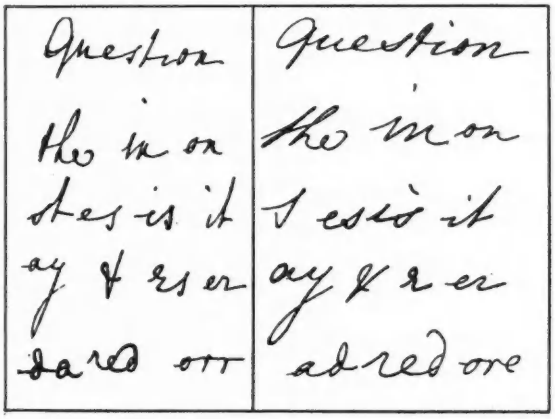


FIG. 4.

TYPICAL WORDS FROM BOTH WRITINGS.

Words on the left, here reproduced by photographic enlargement, are from the letters of Junius, and those on the right the same words as penned by Sir Philip Francis (See also Fig. 5.)

If, however, collateral evidence alone is considered, strong claims can be made out for several other prominent men of the eighteenth century. For instance, Mr. Murray Rose, writing in the *Sunday Times* (September 10th, 1927) brings evidence to prove that Hugh Macaulay Boyd was probably Junius, whilst Mr. James Seton Anderson (*Sunday Times*, August 27th, 1927) argues in support of Lord George Sackville. In the new edition of the "Junius Letters," edited by Mr. C. W. Everett (1927), the Earl of Shelburne is once more put forward, notwithstanding his explicit denial, and the conclusion is supported by many cogent arguments.

It is evident, therefore, that since such collateral evidence can point in more than one direction, the only way of deciding in which direction the balance of probability lies is to make an examination of the documents themselves by modern scientific methods. Certain writing habits characteristic of Junius were pointed out by Taylor. For instance, broken words at the end of a line are indicated by means of a colon, with a second colon at the beginning of the next line (see Figs. 2 and 3). This trait is occasionally to be found in the writings of Francis, but does not occur in the writing of Boyd or of Lord Shelburne. The dotting of the "i" with a dash, recalling the grave accent, is common to Junius and to Francis, but not to the other two. The paper on which the Junius letters are written is of the same make and bears similar watermarks to the paper used by Francis, but this fact has not so high an evidential value as was claimed by Parkes, since paper of the same kind was used in other places than the War Office, for example by the Archbishop of Canterbury.

A comparison of the writing of Junius with the writing of Hugh Boyd and with that of Lord Shelburne shows few points in common, and there is no correspondence between the less obvious characteristics in the writing of either.

For comparing the writing of Junius with that of Francis I took the individual characters *seriatim*. In every instance, without exception, the forms both of the normal letters and of the variations in the writing of Junius were to be found in admitted writings of Sir Philip Francis. Making allowance for the different slope of the pen, the resemblances in the photographic enlargements of different letters, taken at random, are self-evident (Fig. 4). The resemblances do not end here, for it can be shown that similar angles are formed by parts of letters, and that there are similar ratios between different parts of letters. For instance, in the letter "y" in "ay," in the two writings the tail of the letter is six times as long as the curved top (the exact ratios are 1 : 6.5 and 1 : 62). Again, if the heights of the letters, or parts of letters, in the word "question" in the two writings (Fig. 4) are measured, the bottom of the letter "t" being taken as the base line, and these measurements in millimetres are plotted in a graph (as shown in Fig. 5) the two curves will be found to follow practically the same course; this could hardly be a coincidence of chance. My observations therefore confirm the results obtained by Chabot in 1871.

The only conclusion to be drawn from all these material points of resemblance is that the letters of Junius were written by someone whose writing had both the obvious and the hidden peculiarities of the writing of Sir Philip Francis. If to this we add that it was also someone who used the same sort of paper, who had similar writing habits, and who used archaic spelling or made the same spelling mistakes (" compleatly," " intire," " skreen,") the likelihood of anyone but Francis being the writer becomes more remote. And if, finally, all these data are considered in relation to the many external indications, it does not seem too sweeping to apply to the evidence as a whole the rhetorical verdict given on the collateral points alone by Macaulay, when he wrote that " if these arguments do not settle the question, there is an end to all reasoning on circumstantial evidence."

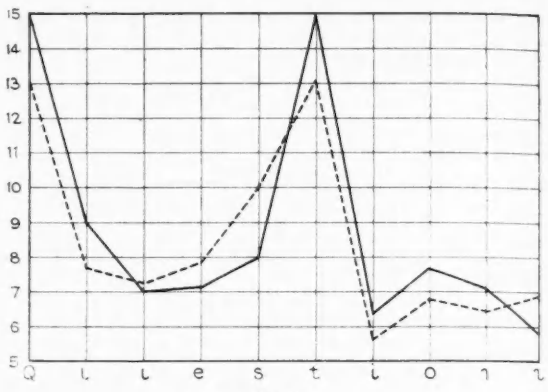


FIG. 5.

RELATIVE HEIGHTS OF SINGLE LETTERS.

The solid line in this graph indicates the letters in the word *Question* as written by Junius and the broken line the corresponding height of Sir Philip Francis' writing.

Correspondence.

THE NEGRO AS FISHERMAN.

To the Editor of DISCOVERY.

SIR,

In your June number there is an interesting article by Mr. James Hornell entitled " The Negro as Fisherman." There is one section (on page 204) in which the definite statement is made that " He takes the adventure in the day's work and can afford to laugh at the white man's effort in the same direction, for no white man has yet landed a tarpon fishing from a boat, though one has been caught by a European casting from the shore with a surf line." The first tarpon caught on rod and line, fair fishing, on the West African Coast, however, was by a medical officer in 1910 at Sierra Leone. That is hearsay, backed by trustworthy evidence. Between 1911 and 1913 I myself caught on rod and line, fair fishing, five tarpon at Lagos, besides hooking many others. The largest tarpon caught and recorded is 165 pounds, fair fishing, of course.

The reasons why tarpon are not caught are (1) lack of anglers who know how to catch a tarpon, or have had the experience or even suitable tackle. (2) lack of decent boats for the work. There are only a few fortunately placed who have a power boat at their disposal, and one cannot fight a tarpon from a dug-out with comfort or security. (3) sharks: on hooking a tarpon on sporting tackle, and having fought the fish until it is tired out, the fish is nearly always a prey to a shark before it can be gaffed. The native with his land-line can skull-drag the fish in, with very little fight, but even then loses to the sharks on occasions. I do not care to skull-drag a tarpon, but to give such a magnificent fish an even chance in a clean fight.

Finally I do not doubt that the native fishes for the tarpon from a canoe, with a line hitched round his big toe and hooks a tarpon, but I have never seen it. A tarpon takes with a bang and will take a twelve ounce tip down into the water and make a No. 6 Von Hoffe reel whiz, so I rather pity that native.

Yours truly,

Rickmansworth, Herts. HUGH COPLEY.

Mr. James Hornell writes :—" Mr. Copley's letter, in which he states that he caught five tarpon on rod and line at Lagos between 1911 and 1913, is of great interest, but as my article dealt solely with fishing in Sierra Leone, it is obvious that my statement on the subject is not affected, Lagos being in Nigeria, hundreds of miles distant.

" The fishing conditions on the coast of Sierra Leone are actually more favourable for tarpon fishing by Europeans than off Nigeria; we have now an authentic instance of successful combats with the King of Fishes in the latter colony, *ergo*, the same success is possible at Sierra Leone. Let tarpon fishers try the latter colony for their next campaign instead of going to Florida; they will have equally good sport at a quarter of the expense and have the satisfaction of keeping the money in British pockets. Suitable motor-boats may be hired at Freetown, but I recommend Kent as actual headquarters; the Government maintains there a comfortable and well-appointed resthouse, in the most picturesque of settings and within a furlong of what is perhaps the best tarpon ground on the coast. I have a photograph taken by myself of a native beaching his canoe in which lay two tarpon, one five feet four inches long and the other just five feet.

" Apart from the above, I am glad to have this opportunity to point out that the basket trap shown in Fig. 1 of my article was inadvertently described in the legend as being used in conjunction with the *bimbe* net; only the left-hand picture relates to this net, the other being a trap used for fishing in creeks and rivers."

COAL MEASURE FORESTS.

IN a letter to the Editor, Dr. F. J. North, of the Department of Geology, National Museum of Wales, points out that a representative collection of the fossils referred to by Professor Seward (" New Light on the Coal Measure Forests," *Discovery*, May), has been presented by Mr. Davies to the Museum. " The collection," he writes, " is unique in that for this coalfield it contains a representative series of the plants from each of the many horizons at which fossil bearing strata occur. It may be of interest to students of fossil botany to know that the collection is now in the public museum."

Afghanistan To-day and To-morrow.

By Sirdar I. A. Shah.

To understand the present situation in Afghanistan, the ancient traditions of the people must be taken into account. The author describes first-hand experiences of Afghan village life, based on recent travels, and discusses the future of the country.

ALTHOUGH there is a central government at Kabul, every man has his own law in Afghanistan. Both the social and the geographical character of the country, therefore, make Afghan village life totally different to the conditions prevailing in the lands that encompass it. Geographically speaking the centre of the country is one mass of high mountains, which, shading away into hilly undulations, run down to broad, well-watered plains, and lose themselves in the corners of the country into mere waste ground and sandy deserts, such as Registan. The hilly nature of the country and the difficulty of transport, coupled with the severity of the weather—especially during the winter months—has developed a mentality amongst the village folk which is self-sufficient and isolated. Each village is populated in such areas as are more easily accessible in the mountainous regions, and at the same time are sheltered from the inclemency of the weather. Villages have also sprung up on important trade routes, where the caravans halt before negotiating difficult passes.

Land Tenure.

Probably there is no country in the world where the land tenure is so peculiar as in Afghanistan. There was no system of lease—or at least until recently—and one cannot hire so many acres for so many seasons. The land belongs to the man who tills it and who can generally trace the ownership to the very early stages of Afghan history. He can neither sell nor mortgage it, although he can raise a loan without interest on the crops, and that, too, if the village committee grants it. As the country is divided into clans, the people of one clan generally inhabit a number of villages, and the head of the clan is virtually the master over the bodies and souls of his clansmen, provided always that he is backed by the priests. Populated as each village is by a homogenous community with common language, religion and interests, there is—beyond the blood feuds—scarcely ever any discord amongst the inhabitants of the same village.

Great reverence is shown to age in Afghanistan, and therefore the village committee, which meets every Friday after prayer, is comprised of its oldest members, called the "greybeards." This village committee holds a weekly Court in the public square, where all the cases of the week are tried, from cattle lifting to murder. Fines are imposed and even imprisonment, and carried out to the letter. There is no police, as such, to enforce this clan law, and yet once the "greybeard" has passed the order, the culprit has either to obey or quit the village, because every member thereof considers it his duty to have the law enforced. I have seen men socially boycotted for disobeying the clan law, water even being refused.

The Village Priest.

But it is very important to appreciate the fact that behind the village elders committee there is a predominating influence of the clergy. The Mullah, or the village priest, is considered second only to the head of the clan. He is respected for the reason that he is generally the only literate man who could interpret the revealed laws of Islam, and before any order can be passed, it is he who has to pronounce that it tallies with the Shara or Muslim Law.

Perhaps the most intricate case that comes before the village committee is that of divorce. It is grotesquely wrong to suppose that in Afghanistan where the Mahomedan Law is very strictly observed, a man can divorce his wife by merely pronouncing it. The woman, also, contrary to the accepted idea about Eastern people, has a right to bring the divorce suit. The whole village in that case becomes the jury, and whereas a divorced wife is practically a social outcast, frequently a man—a divorced husband—finds his native village almost unlivable as nobody will employ him. Respectable people would never entertain him, and he would certainly never get a second wife in that village. Two other offences are very severely punished according to the village law; one is theft and the other is being shot in the back at any inter-clan fighting. The punishment of cutting off the hand by which anything was stolen is now generally abandoned in favour of flogging the thief. In the case of a wound in the back, the man is branded as a coward who has run away from the field, and is therefore put on transport duty in any future clan warfare. The shame thus inflicted on a man put away from the fighting

force of his kinsmen is considered sufficient punishment.

Although the individualist spirit is witnessed in Afghan village life, nevertheless, in so far as there are no farm labourers and as modern agricultural machinery is not introduced in the country, the farmers help each other by periodically loaning the services of all their men relations at sowing or reaping time. For example, my next-door neighbour might one day come in and request all my brothers and even my aged father to plough his new watered field. Next week I might make the same request from his relations. And so the work of husbandry is carried on from season to season amongst the highland farmers of Afghanistan. There are, as a rule, two crops, the chief one being wheat and barley. This is sown somewhere about October, and the seed lies buried the whole winter under the snow. When March is well on and the snow is melted, much work is done in the field, and the crop ripens about July, when the fruit is also in full yield. During the long winter, when outdoor work is not possible, the peasant life does not exactly slumber. It is time for knitting the rough thick blankets from the highland wool, also a great number of villagers weave carpets, especially in Northern Afghanistan.

Hospitality.

In the dark winter nights, the stranger who enters the courtyard of an Afghan farmer may have to plough his way through a foot of snow, before reaching the threshold. Provided he has escaped the wrath of the Afghan hounds which a moment before were sitting mutely under the portico, he seeks admittance by rattling the door chain, for bells there are none. A small wicket is opened in response, and from behind bars two piercing, searching eyes are directed towards him. From a hasty look, but without speaking, the man inside discovers whether you are friend or foe, but in either case he admits you, for according to the Afghan law of hospitality, every stranger within their gates has the right to protection and entertainment. In a little alcove of the room, warmed by the stove, the stranger is given the place of honour, where he sits crosslegged on the carpet and green tea is immediately brought. No questions are asked, and before the green tea is finished, a tray of food is served, for as an Afghan proverb says that "a hungry man is a sick man." That illness they certainly hasten to cure. He is then conducted to another apartment where a bed has been prepared, and beyond an occasional question whether all requirements for the night's comfort are satisfactory and fully provided, nobody interferes with his "right to rest" till the morning. For the Afghan farmer says, "This house is your house," and a real haven it can be if a man is pursued by enemies. The Afghan host and his sons guard the visitor and fight if necessary on his behalf. "So sleep without a care," he says, as he closes the door—such is the law of hill hospitality in Afghanistan.

An extraordinary example of this came under my own observation when I was travelling in the backwoods of the country. The chief of a clan was regaling me with stories of old blood feuds, while the sun was just sinking behind the wall of White Mountains, and as soon as we finished our evening prayer and the night watchmen had occupied their respective loopholes in the turret of the walled village—for a raid from a rival clan was expected that night—we were startled by the shrill challenge of one of our scouts.

Rapidly he fired in the direction from which he thought he had heard running footsteps. The Chief, thinking it to be a signal of the raid much earlier in the night than he expected, shouted orders to his men to get ready. But curiously enough no challenge was returned from the man at whom the scout had fired. And amidst the tense silence of a time when an enemy is expected, came a long-drawn-out sound from the gloom of the night, "Mercy in the name of Allah! Protection in the name of the Creator, I seek!" Within a few minutes a young man, whose left arm hung lifeless by his side, and whose long tresses were dishevelled, his shirt half torn off his body, was brought before the Chief. Without asking a question of him, he was given tea and food, and ointment was hurriedly made with fresh butter and chicken's blood with which the man's arm was treated. And now the fugitive voluntarily told us of his exploits, and the reason for his present flight. It appeared that he had borrowed some money from a young

AFGHAN FARMERS.

Modern agricultural machinery is not yet introduced into Afghanistan and the farming is conducted in a primitive way. The group here illustrated is engaged in hand threshing.

man of the Chief's village, and as he was grazing his sheep he saw the lender leading his three camels through the pass. He demanded the re-payment of the debt there and then. The borrower thereupon coming close to the lender, buried the blade of his Afghan knife in his stomach, saying, " Here is thy payment, and as a receipt I take the three camels." Some men, seeing the treachery, pursued him, and it was they from whom he sought refuge.

From the description of the stabbed man which the fugitive gave, I was horrified to learn that the murdered man was no other than the younger brother of the Chief, his host, but beyond the fact that red mounted to his brow, the hill Chieftan showed no further emotion. Then, stroking his beard, he drawled out, " Knowest thou that the man thou hast stabbed was mine own brother, but since thou hast sought shelter and protection in Allah's name, in His name I give it. Have more food and tea, till the dawn rest thyself here, then go, for if after the first ray of the sun strikes yonder minaret and thou art found in the village, thy bones will dry in the glen of thy crime."

THE OLD COSTUME—
Group of frontier men, showing the costume of the Afghan warrior, including the turban and skirted coat. Attempt to enforce changes by law has caused much disturbance.

Needless to say, the first rays of the sun found the culprit many a mile from that minaret.

In contrast to this wild and fascinating life, Kabul, the capital of the country, showed a totally different picture—at any rate during the reign of ex-King Amanullah. The new part of the city was lighted by electricity, roads were made, palatial buildings in European style were erected, and many shops stocked western articles. Liberalism unknown to old Afghan tradition was introduced into the society of the town, especially regarding the unveiling of women. Innovations in dress were enforced by law, and it was made

—AND THE NEW.
Ex-King Amanullah is here seen addressing the people after the Friday prayer, the Westernized uniforms of his officers being in striking contrast to the old traditions.

perfectly clear that the western method of living and outlook on life was to be the future method of Afghan people. As an example of this Westernization, government orders were put in the public parks that any man found there not wearing European dress and bowler hat would be fined five rupees (six shillings and eightpence). In the villages, far removed from the expensive life of the town, it may be noted that five rupees will keep an Afghan peasant's family for a month. To this was added the flaunting of the influence of the priests, which perhaps was the last straw that broke the camel's back.

Gradually these ideas of Westernization were forced upon the people of outlandish parts of the country. It was enacted that the village elders should change their flowing garb in favour of European dress, that they were to look to the Westernizing methods of Kabul rather than to be guided by the village priest, and obey the rural committees. In addition, land taxes were increased to pay for all the modernizing movements going on in the capital. These and many more excesses cut right through the hoary traditions of a conservative people who had so long nursed their ideas in their mountain fastnesses. I, nor any other Afghan, am not against Westernization as such, provided certain phases of it could be blended with the native ideals which King Amanullah hopelessly failed to do. Consequently the village life was so deeply agitated as to cause widespread revolution against the person of the author of these reforms. The pace was forced beyond all measures and the best observation that can be made about the situation is that a very good thing was done in a very bad way.

Restoring the Studium of Constantinople.

By Stanley Casson, M.A.

Work is now in progress on the Church of St. John of the Studium, the most ancient Christian building in Constantinople where it is believed the relics included at one time the head of the Baptist. From the removal of plaster and weeds, discoveries of architectural interest are being made.

THE church known as the "Studium" at Constantinople is the most historical and the most ancient Christian building in the city. It stands not far from the Golden Gate, and was originally the church of a very large monastery which held a thousand monks. It was called the Studium after the name of a patrician who founded it in 463 called Studius, and was dedicated to St. John the Baptist. Until last year it was one of the most neglected and unhappy ruins in Stamboul. Its floor was breast high with weeds and brambles and the derelict columns stood in a wilderness. It had been converted into a mosque but, even so, had fallen into complete disrepair.

The church is important beyond the ordinary because it is the one surviving example of a basilica church in Constantinople, and because its architectural and mosaic decoration were reputed to be of the first order. Some desultory excavations made some ten years before the War had damaged as much as they had revealed, but they had made it evident that the mosaics were of remarkable character. Last year the authorities of the museum at Stamboul decided to save what could be saved and to repair while repairs were still possible. The results have been most interesting and valuable.

First the columns of the narthex have been completely disengaged from the mass of Turkish plaster and whitewash which encumbered them.

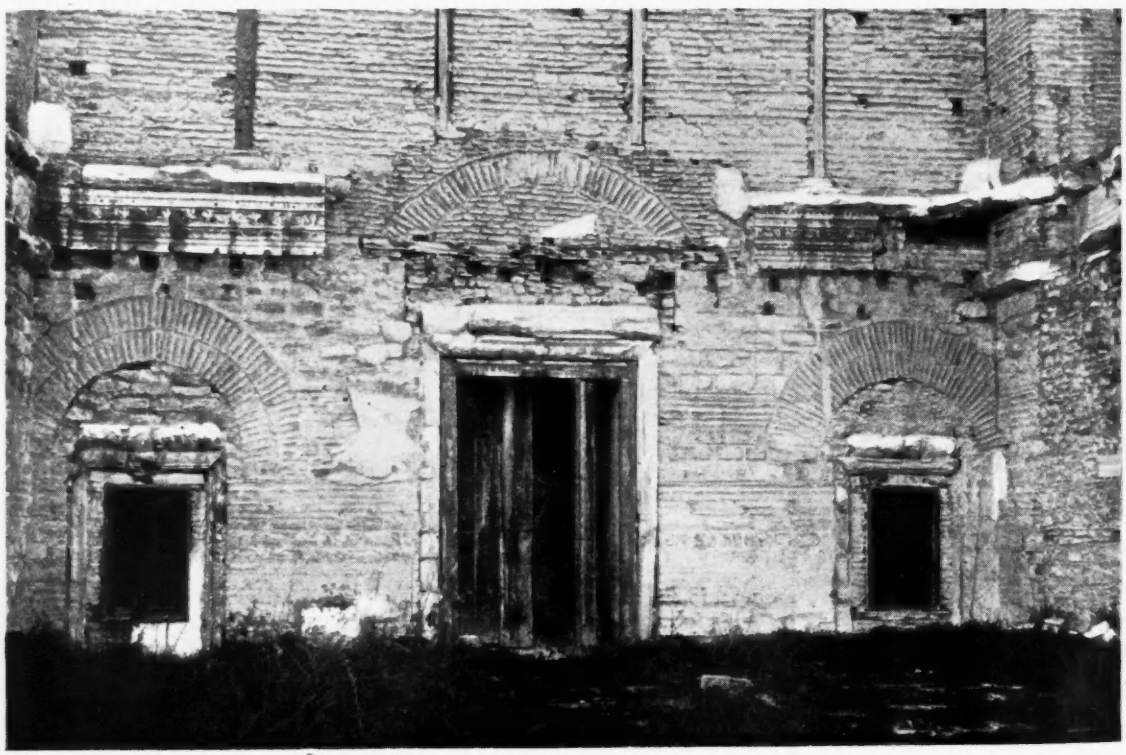


FIG. 1.
INTERIOR OF THE CHURCH AT THE EAST END, SHOWING THE FINE DECORATIVE CORNICE

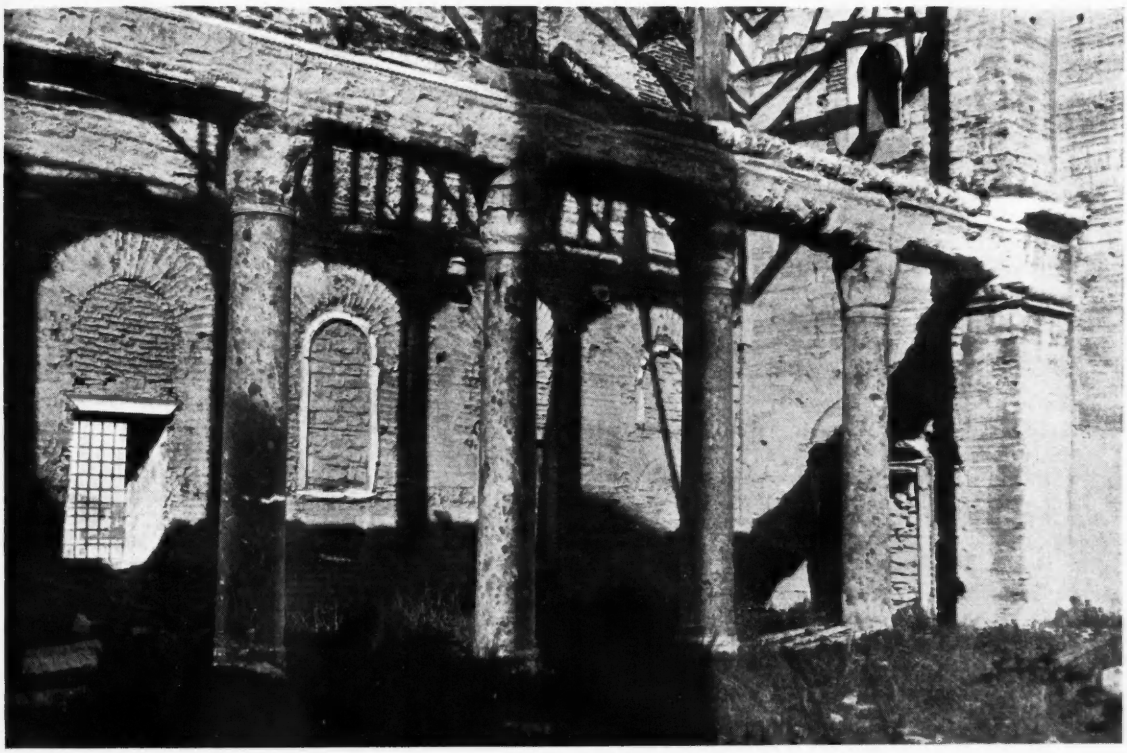


FIG. 2.
THESSALIAN COLUMNS IN THE NAVE OF THE CHURCH, BEFORE RESTORATION.

The capitals so revealed are seen to be of exquisite workmanship and severe classical charm. The columns are of the green marble of Carystos and the capitals are in the finest Corinthian style, carefully and elaborately carved, and in almost perfect condition, thanks largely to the plaster which protected them from vandalism. Most of the other Turkish additions have now been removed and the entrance to the body of the church is now one of the most beautiful things to be seen in the city. The courtyard before the entrance still retains its ancient Turkish aspect, with a small fountain in the centre and trees overhanging, and, in consequence, it adds greatly to the beauty of the building; in fact, I know of no more peaceful or more romantic spot in all Stamboul than this lovely courtyard.

Inside the body of the church is now cleared of weeds and fallen rubbish. The side columns are of Thessalian *verde antico* and still hold their architrave (Figs. 2 and 3). They are all monoliths and, as such, the most costly of all ancient columns, for the Thessalian marble is not easy to quarry into monoliths of this size, and must have been one of the most expensive marbles in the ancient world. Much remains to be done to the great walls and the fine architectural cornice that ran round the inside of the church is being strengthened and repaired (Fig. 1).

The floor of the nave was originally entirely covered with mosaic, not of the usual Roman or Byzantine type made of small tesserae, but rather of inlaid marble fitted into patterns not at all of the usual kind. Formal

FIG. 3.
RESTORATION WORK IN PROGRESS.

geometric designs of maeanders and guilloches run lengthways down the church, but at intervals are seen strange designs of small animals, some heraldic, others naturalistic, usually in the corners where the nature of the general pattern changes (Fig. 4). Large stretches of these mosaic patterns had perished, partly by the growth of weeds and partly by the depredations of tourists, who seem to have helped themselves lavishly to these souvenirs, though what the value or beauty of small pieces of marble taken from the picture which they form I cannot imagine. Still, much of the mosaic had been rebedded in concrete and relaid, and it can now be considered safe from the clutches of tourists or small boys.

So much happened at this church and monastery that it can certainly be looked upon as the most venerable of all the smaller buildings of the city. Here was kept one of the most precious Christian relics, the head of St. John the Baptist. In the Sultan's treasury was found a Byzantine reliquary which is believed to have held this relic. It can now be seen in the Treasury Museum of the Seraglio. It was one of the very few Christian relics which were taken possession of by the Turkish conquerors at the capture of the city in 1453. As they came in from the walls they must have entered the Studium and robbed it of its treasures, but this particular relic seems to have escaped the melting pot and to have fallen into good hands.

In 1204 the Crusaders had pillaged the church and practically ruined it, but the head of St. John, which they were seeking, had been spirited away to another monastery. They did subsequently find it, however, and the head was sent to Amiens, but somehow the reliquary seems to have escaped. The date of the mosaic is uncertain, but it seems to have been laid after the conquest by the Crusaders, when the church was put into good repair again by the Emperor Michael Palaeologus, who had recaptured the city from the Latins.

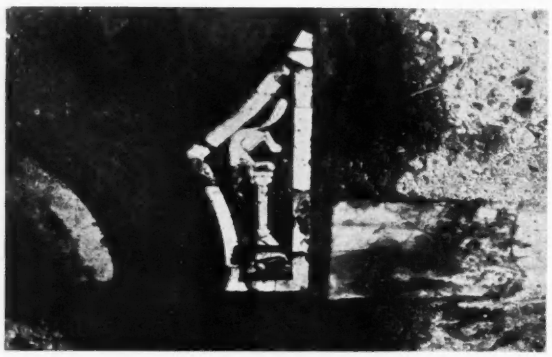


Fig. 4.
FLOOR MOSAIC IN THE STUDIUM.
This represents a squirrel balancing on a column, and is typical of the designs.

The church is remarkable for one curious fact : in it was buried one of the sons of the Sultan Bayazid I. The young man was converted to Christianity before the capture of the city by the Turks. It always maintained a strong spirit of independence, and throughout the disturbances of the Iconoclasts it often gave sanctuary to famous Icons, which were being sought for during the campaign of destruction of sacred images and paintings.

Adjoining the church is one of the only surviving parts of the monastery to which it belonged. This is a large underground cistern of great architectural beauty. Its roof is intact and supported by twenty-four granite columns surmounted by lovely acanthus capitals. It is now used as a straw depot, but can be seen.

Few visitors visit the Studium because it is hard to find and not well known, but now that its restoration has been undertaken it is one of the most beautiful of the ancient monuments of the city.

The Grand Canyon.

YELLOWSTONE PARK, the largest of the national parks in the United States and one of the earliest to be established, is chiefly remarkable for its geology. Volcanic accumulations make up a large area and attain a thickness of many thousands of feet. The most striking feature is the Grand Canyon, carved by the Yellowstone River on its way to join the Missouri.

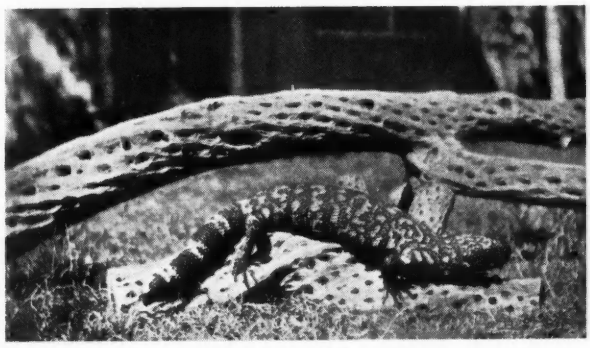
Discoveries throwing an entirely new light on the volcanic history of the park were described recently at the Royal Institution by Professor O. T. Jones, F.R.S., who in conjunction with Professor Field, of Princeton University, examined the Canyon near the great Fall where sediments had been observed. These proved to be sands, muds and conglomerates which extended from the rim of the canyon nearly to the bottom. They proved beyond doubt that the canyon since its excavation had been dammed at some point below, and in the lakes resulting from this process the sediments accumulated, filling the canyon to the brim. Further investigations indicated that the dam was caused by great flows of lava, which entered the canyon from the north and flowed against the drainage of the Yellowstone and its main tributary, the Lamar River. Before the damming episode, the canyon had been eroded in three or four stages or cycles, each new stage being initiated by uplift of the region. The lava flows entered the canyon while the last cycle of erosion was in progress.

The Gila Monster of Mexico.

By Lt.-Comm. C. M. Cree, R.N. (Retd.).

Found only in Arizona and New Mexico, the Gila monster is one of the two poisonous lizards. Graphic accounts are still given of its dangerous habits, but this curious creature is chiefly interesting for its rarity.

WHILE it is well known to everybody that the world abounds in many varieties of poisonous snakes, few of us even suspect that there is one family of lizards known to science, namely, the Helodermatidae, the members of which are very highly poisonous indeed, and which from the point of view of the potency and activity of their venom could put many of the poisonous snakes entirely in the shade. This lizard family, the Helodermatidae, consists of only two representatives of the genus—the *Heloderma horridum* and the *Heloderma suspectum*. The second of these, with which it is proposed chiefly to deal in this article, is a native of the States of Arizona and New Mexico in the United States of America. It inhabits the dry, arid, desert type of country adjacent to the Gila (pronounced "Heela") River, which rises in the Rocky Mountain Range in New Mexico, and flows right across Arizona in a general south-westerly direction until it joins the course of the Colorado River at Yuma, Arizona, in the extreme south-west corner of that state, after which the confluence runs almost due south and enters the Gulf of California. It is from the Gila River that the reptile takes its popular—or should it be unpopular?—name, the Gila monster.



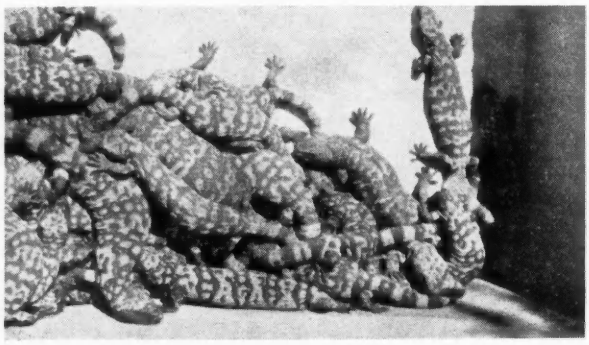
THE GILA MONSTER.
Mounted specimen of *Heloderma suspectum*, showing the proportions of the body and the curious colour markings.

The Gila monster is a very heavy-set lizard and generally measures some twenty to twenty-four inches in length, although the writer has seen one specimen which just reached the twenty-seven inch mark. A length such as this, however, is undoubtedly rather exceptional, the *average* length probably being nearer to twenty than twenty-four inches. The skin of the Heloderm differs from that of almost every other known lizard in that it is completely covered with small tubercles resembling beads, each of about one eighth of an inch in diameter, the effect of the whole being somewhat reminiscent of the skin of a toad. The colour is generally a yellow, pinkish yellow, or orange, with large irregular black or brown splashes arranged in more or less haphazard fashion over the entire body. Over the tail portion these markings usually fall into a series of irregular alternate brown and yellow rings about one-half to one inch in width. The extreme tip of the tail is almost invariably black or brown, and these colours also predominate on the head and limbs. There is great variety displayed in the markings, and although there is, of course, a general similarity in all, it is very unusual to see two specimens with identical or even nearly identical designs. It is often maintained—with but slight regard for the strict truth—that every letter in the alphabet may be traced on the markings of the skin of the Gila monster, and although a statement of this nature is quite fallacious it does emphasize that the distribution of the colour follows no very definite design.

In conformation the reptile is very squat and thickset. The head is very massive and somewhat depressed. The muzzle is broad and generally of a deeper black than any of the rest of the body, while the tongue is of a purplish-black, rectangular, and bifid at the tip. The jaws are very wide, heavy and powerful, and are capable of such a bulldog grip that if, for instance, they once obtain a fair grasp of their prey, it is next to impossible to separate them to remove the victim, unless the reptile is either killed, or voluntarily releases its hold. The eyes are small, shiny and black, and are not a great deal larger than one of the reticulations covering the body and head of the lizard. The limbs, which are strongly developed,

are decidedly short, giving the creature a peculiarly low-set appearance, and each limb is terminated by five claws which bear rather a striking resemblance to human fingers. The tail is very thick, swollen, and generally rather blunt at the end. In size it is normally about one-third of the total length of the lizard. Its function is reminiscent of that of the hump of the camel, since it acts as a form of storehouse for fatty tissue laid in reserve against lean times and hibernation periods.

As was mentioned earlier, the home of the Gila monster is in the arid, desert regions adjacent to the Gila River in Arizona and New Mexico, and this lizard is found nowhere else in the world. The reptile is not viviparous, but lays its soft-shelled eggs, which are very large indeed for the size of the parent, being almost as large as a hen's egg, in excavations in the sand, where the young are hatched out by the natural warmth of the climate. Normally the food chiefly consists of very small mammals, other varieties of lizards, small snakes, frogs, worms, centipedes, insects, and the eggs of small birds, snakes and lizards. Considering the partiality that the Gila monster displays for eggs, there is very little doubt that the eggs of its own species would not be disregarded as articles of diet.



FORTY LIVE MONSTERS!

This group of Gilas was photographed in the Reptile Gardens at Phoenix, Arizona, and shows young as well as full-grown animals.

Contrary to some opinions the reptile is not nocturnal in habit, but appears to enjoy thoroughly bright sunlight and warmth in which it becomes most active, and on occasion, most decidedly ferocious. In such weather the lizard will move surprisingly quickly for so ponderous appearing a creature, and when it is alarmed it will show considerable temper, opening its mouth and hissing, or rather making a guttural warning sound resembling a prolonged "ahh," with its throat. If further annoyance is occasioned or the reptile becomes seriously alarmed it may snap viciously, and will sometimes rear itself up on its hind legs to its full height and bite in all directions, moving about with great celerity. Incidentally, it may be of interest to relate that in the local folklore of the Gila country, even the breath of the Gila monster is reputed to be of an absolutely deadly character. Of course, while it is true, as the writer can vouch, that the lizard is associated with an unpleasant reptilian smell, this local theory of a "poisonous" breath is altogether without foundation.

In cold weather, the Gila monsters become more or less torpid and sluggish, and can be picked up by the back of the neck and handled quite easily and with very little danger, as they seldom attempt to bite under such conditions.

The poison apparatus of the Heloderm is quite unique, and differs entirely from that of any of the three main types of poisonous snakes. In the Gila monsters the poison glands, which are two in number, are each formed of four lobes. These glands are situated one on each side of the base of the lower jaw instead of being either at the rear of the upper jaw, or contained within the body as is the case with the venomous snakes. The means of utilizing the poison is also quite different. No fangs or grooved teeth such as are found in snakes are present in the upper jaw of the Gila monster. Instead, the poison of the animal is conducted from the glands through four ducts on each side of the lower jaw to the bases of the eight grooved teeth, which are loosely set in a somewhat forward position in that jaw. These teeth are grooved with canals or channels on the inside through which the venom is led. When the reptile grips its prey it makes a grinding movement with its jaws which contracts the glands, thus forcing the poison up through the grooves in its teeth and into the wounds caused by the bite.

In general, the other representative of the genus—*Heloderma horridum*—very closely resembles its brother just described, differing mainly in the three following particulars:—(1) the colour, which is black with yellow spots; (2) the tail, which is a trifle longer, less swollen, and more pointed at the end than that of *H. suspectum*; and (3) the habitat, which is practically limited to the Republic of Mexico, and chiefly to the western part of that country.

A few years ago there was a very considerable amount of discussion as to whether or not the

Heloderm was really poisonous. The discussion originated from the fact that a number of persons who had sustained bites from these reptiles reported very little or no ill-effect. These results were, in all probability, due to the lizards only being able to succeed in biting with their front teeth which are not grooved, and consequently no venom could enter the wounds. Quite different stories would have been told had the Gila monsters managed to utilize even a small quantity of their venom, and to this the number of human deaths in Arizona and New Mexico from the bites of these reptiles will bear ample testimony.

One instance of the deadly character of the venom of the Gila monster, of which the writer has evidence, may be related. Two Mexicans, who had had a difference of opinion with a third, in which they had come off rather the worst, decided to take their revenge on their adversary. Accordingly they contrived to secrete a large Gila monster in their unfortunate opponent's bed. Here, of course, the conditions were splendid for the lizard to utilize its venom to the full and with every advantage, and when he got into bed the unsuspecting Mexican was severely bitten on the toe, and died very shortly afterwards.

A certain Madame Phisalix, a French scientist, who made an extensive study of the venomous reptiles in general, in the course of her researches conducted experiments on the reciprocal actions of the poison of the Gila monster and that of the common viper. Her experiments showed that the viper, injected with the poison of the Heloderm, was almost immediately stupefied and died within twenty-four hours, while the Gila monster withstood the action of a similar amount of the viper's venom for fifty-six hours before expiring. Incidentally the lady was herself bitten by a Heloderm during her experiments, and although only a few of the grooved teeth of the reptile penetrated her flesh, she relates that she was laid up for nearly three months as a result.

Food and Habits.

In captivity the Gila monster gets very quickly docile and gentle, especially if it is kept out of bright sunlight, and apparently its normal disposition is by no means a vicious one. The creatures show no disposition to quarrel amongst themselves and are very easily kept and fed. Their sole requirements are water, and a raw egg broken into a basin or dish with perhaps some very finely chopped raw meat mixed up with it, furnished once or twice a week. They lap up this food with their tongues somewhat in the manner that a dog drinks, and often during the course of a meal they get either absent-minded, or go, apparently, to sleep. This habit necessitates reminding them at frequent intervals of the business in hand, the reminder generally taking the form of rubbing their noses in the food dish to bring home to them forcibly the fact that it is a meal-time. When they have lapped up sufficient to give them a satisfactory swallow they crane their heads and necks upwards, assuming a characteristic lizard position, and let the food ooze down their throats with every symptom of complete enjoyment.

In concluding this article it should be stated that while there is absolutely no doubt that the Gila monster is, under certain circumstances, a very dangerous reptile indeed, it is of no great economic importance, as it is fortunately not frequent that suitable opportunities occur for it to display its deadly characteristics. This is perhaps just as well for the peace of mind of the residents of the country surrounding the Gila River valley.

Darwin's "Noble Weakness."

WRITING in a new preface to "The Origin of Species" (Oxford University Press, 2s.), Major Leonard Darwin throws interesting light on the attitude of his father to contemporary criticism. One of the reasons, he says, why the earlier editions of the book are of importance may be illustrated by quoting Huxley's words to the effect that Darwin "had the noble weakness of thinking too much of other people's doings and too little of his own." Where changes of opinion appear in later editions, they were probably often due in no small measure to the criticisms of other scientific men; for we know that the author wrote to Hooker in 1862 that "such men as you and Lyell thinking that I make too much of a Deus of Natural Selection is a conclusive argument against me."

Would such opinions, his son asks, have been considered conclusive by anyone but Darwin himself? The explanation, however, is that the great pioneer held that what was then mainly necessary to ensure progress in the natural sciences was a belief in evolution; and he therefore did not care to insist too strongly on any one of the methods by means of which descent with modification had been brought about, although he firmly believed that natural selection had been by far the most important method. "It is only those who knew my father well who can realize how little any personal feeling would stand in his way in modifying his judgments in consequence of any argument brought forward by that small band of friends whose views he held in such high esteem."

How the Chemist Helps the Archaeologist.

By William Foster, A.M., Ph.D.

Professor of Chemistry in Princeton University, U.S.A.

Details of the coloured materials found in the recent excavations at Corinth have been elucidated by the writer, who has carried out this interesting research in conjunction with the excavator, Professor Shear. How chemistry has shed light on ancient manuscripts is also described.

SINCE chemistry deals with the study of the composition and properties of all material things, it has innumerable applications in the arts and sciences as well as in everyday life. It has been of great service to the archaeologist, for chemical tests and analysis have long been used in the identification of the various kinds of material things with which the archaeologist has to deal, such as metals and alloys, pigments and dyes, embalming materials, pottery, glass and enamels, ancient buildings and tombs, and manuscripts and inks.

Earth Colours.

The use of pigments or colours for decorative purposes began in the prehistoric period. Sir Flinders Petrie puts the date of this period in Egypt at 8000 to 5800 B.C. The pigments used by the ancients were largely earth colours, such as the yellow and red ochres, *terre verte* (a green pigment—a compound of iron), copper-bearing minerals, and naturally occurring vermilion (cinnabar). The minerals realgar and orpiment (sulphides of arsenic) were also available. The former is orange-red in colour and the latter is yellow. In addition, charcoal (carbon) and black chalk were used as pigments. Drawings were made in charcoal and in red and yellow ochres by palaeolithic man; for example, their drawings represent with some degree of perfection certain animals which are now virtually extinct in Europe, such as the bison. While these pigments are not as durable as carvings in stone, some are remarkably well preserved.

The favourite colour for glazed vessels produced in Egypt in prehistoric times was blue to green, due to copper compounds. Later on, but at a very early date, the famous Egyptian blue was used. It was a synthetic product—a richly coloured glaze, glass, or frit, containing copper. Cobalt blue was apparently used by ancient potters, but not by painters until a comparatively recent date. Ultramarine, a pigment produced from *lapis lazuli*, the most famous of all blues, was not used in ancient times, but was a favourite colour with mediaeval painters. Prehistoric slate palettes and mullers for rubbing down pigments have been discovered. The pigments were no doubt rubbed down with a medium.

Many of the Etruscan frescoes are famous and very beautiful, as also are those in the palace of Knossos, in Crete. This wonderful palace was probably decorated about 1500 B.C.; the pigments used were yellow and red ochres, black chalk, Egyptian blue, and lime for white. It is probable, therefore, that there were commercial relations between Egypt and Crete when the palace of Knossos was decorated.

Excavations in progress at the present time are unearthing pigments used in antiquity. For several years Dr. T. L. Shear, Professor of Classical Archaeology in Princeton University, has been engaged in uncovering a theatre at Corinth.* Of the remains discovered in this theatre, the earliest date from about 350 B.C. As a result of these excavations it is known that the Corinthians were acquainted with certain mineral pigments or colours. One of the most interesting discoveries made in the theatre district in 1926 was a rude, bowl-shaped clay pot containing a red pigment. This pot was uncovered at a depth of 5.25 metres, in the sanctuary of Athena Chalinitis, which adjoins the theatre. The pot does not resemble any Greek pottery of Corinth, and the clay of the vase is not of the Corinthian type. It appears, therefore, that the vessel was imported from some place where such rude ware was still being manufactured several hundred years before the beginning of the Christian era.

"Realgar."

The writer analysed a specimen of the contents of the pot and found it to be realgar (Arabic *rehj-alghar*, meaning powder of the mine or cave). This mineral occurs in Nature; it is a sulphide of arsenic (As_2S_2). Realgar was known in the days of Aristotle. According to evidence found in early writings, it seems reasonably sure that realgar has long meant the same as Greek *sandaraka* and Latin *sandaraca*. Theophrastus, successor to Aristotle in the Peripatetic school, says

* Described by Professor Shear in *Discovery*, 1927, page 195.

that realgar was a red colour used by painters; and Pliny states, on the authority of Juba, that it occurs on the island of Topaz in the Red Sea. It was perhaps found in many places. According to Strabo, Greek geographer and historian, realgar was mined in shafts near the city of Pompeiopolis, Paphlagonia, near Sinope; and the mines were worked by slaves and condemned criminals. The working conditions were hazardous, and Strabo says that poisonous vapours arose from the earth. This appears to be very doubtful. It is probable, as thought by Blümner, that the ill effects were due to fine dust which was inspired by the labourers. According to Aristotle, horses and other beasts were killed by the administration of *sandaraka*; and Galen, a Greek who became the imperial physician at Rome, recommended that it be mixed with butter and used as a poison for scorpions, very much as arsenic preparations are now used in orchard and garden to kill lowly forms of life.

In this connexion it is of interest to know that there is an arsenic mould (*penicillium brevicaule*) which by its action on certain wall-papers is said to produce a poisonous gas containing arsenic (diethyl arsine, $AsH(C_2H_5)_2$, a derivative of the highly poisonous gas arsine, AsH_3); but it is not at all probable that this gas was formed in the realgar mine mentioned by Strabo. It is also of interest to know that Sinope had commercial relations with Greece; the realgar found at Corinth was probably imported from the mine in the mountains south-west of Sinope. The mineral was probably expensive.

Realgar was produced artificially at an early date, and it appears to have been discovered by accident. Pliny says that Nikias was the first person to use the synthetic pigment. He was the artist who painted some of the marbles for Praxiteles.

Egyptian Blue.

Professor Shear reports that among the more notable discoveries made in the excavations of Corinth were several pieces of marble sculpture on which red paint was more or less preserved. He has also discovered specimens of a blue pigment in the theatre district of Corinth. These specimens were examined by the writer and reacted to the tests for Egyptian or vestorian blue. This pigment was produced synthetically and used in Egypt for over two thousand years; it disappeared from the artist's palette somewhere between the second and the seventh century. As stated before, Egyptian blue is a richly coloured glaze or frit. Vitruvius says it was prepared by heating together sand, soda, and copper, and that it was originally prepared in Alexandria. In his day (the time of Augustus) he said it was manufactured in Puteoli. According to Professor Laurie, Principal of Heriot-Watt College, Edinburgh, analysis of samples of Egyptian blue shows that it usually contains lime, alumina, silica, soda and copper. He says it can be produced by heating a mixture of sand, copper carbonate, soda and lime to a temperature between 850° and 900° C. for several days.

The specimens of the pigment examined by the writer were found to be very insoluble, being virtually unattacked by the powerful solvent, aqua regia. One formula assigned to Egyptian blue is $CuCaSi_4O_{10}$, a silicate of copper and calcium. I also examined a specimen of a bluish-green pigment discovered by Professor Shear at Corinth, which proved to be a mixture of silica and of a compound similar to Egyptian blue. Professor Laurie says that if the temperature be raised too high in the preparation of the blue pigment, the green is obtained which was used so much in Egyptian painting.

Ancient Perfumes.

A Greek sarcophagus was uncovered in 1928 north of the area of the Corinthian theatre, and there was found inside the tightly-closed coffin a light mass somewhat resembling bark or old wood; it possessed a faintly aromatic odour. Chemical tests showed that the material is rich in resinous matter; when burnt, it yielded a small amount of white ash. These tests indicated that the matter is of vegetable origin. This conclusion was confirmed by a microscopic examination, which clearly showed the presence of resinous substances and also revealed the cellular structure of vegetable tissue or wood. The character of the material examined suggests that it came from an incense tree, which may have been brought from the East.

Frankincense (*franc*, free, pure + *encens*, incense) is a fragrant gum resin, obtained from various East Indian trees. It was used by the Egyptians, the Jews, and other ancient peoples for embalming, in connexion with funeral obsequies, for fumigation, etc. (see 2 *Chron.* XVI, 14). Frankincense was the most common incense offered to the gods among the Greeks. It is said that King Antigonus had a branch of the true frankincense tree sent to him; also, that a branch of an incense tree was carried by an ambassador from Arabia to Rome, in the days of Pliny. Sweet-smelling gums and resins of the countries of the Indian Ocean were imported by Greece after the Mediterranean trade with the East was opened up by the Egyptian king Psammetichus (about 664-610 B.C.).

The chemist has also been of service in the study of

manuscripts and inks. It is known that the ancient Egyptians and Chinese prepared and used inks. Sir Flinders Petrie discovered a papyrus bearing written characters as old as 2500 B.C. It appears that ink was invented in China earlier than 2500 B.C. These inks were prepared from carbon (soot or charcoal) mixed with gum arabic, glue, or varnish. The Romans used as ink sepia, the black pigment secreted by the cuttle-fish. It is of much interest to note that the word "ink" is derived from the late Latin *encaustum*, Greek *egkauston*; the purple ink used by Greek and Roman emperors, from *egkaiein*, meaning to burn in.

Iron-gall inks were prepared at an early date. Theophilus, a monk of the eleventh century A.D., was perhaps the first writer to describe the preparation of nut-gall inks. Pliny, however, in the first century A.D. knew that paper treated with ferrous sulphate (green vitriol) could be blackened by immersion in an infusion of nut-galls. These inks were prepared by treating extracts of galls, bark, etc., with ferrous sulphate, ferrous tannate and ferrous gallate being formed These compounds lack colour, but when exposed to the air they are oxidized to ferric compounds, which are black. In the manufacture of nut-gall inks, a dye is now added to make the ink visible when first applied.

Chemistry has been most helpful in the restoration of certain faded manuscripts, as shown by the following illustration. In the spring of 1928 Dr. Charles C. Marden, Professor of Spanish in Princeton University, made a special trip to Spain to search for the missing portions of a manuscript upon which are inscribed writings by Gonzalo de Berceo, a famous thirteenth century Spanish poet. The manuscript is parchment, and dates from the first half of the fourteenth century—long before America was discovered. After a systematic search, Professor Marden was fortunate enough to find the missing parts of the manuscript and was permitted to bring them to Princeton for translation. Being unable to read certain portions of the manuscript, due to the fading of the ink, he requested the writer to treat the faded parts with a chemical reagent with a view to their restoration. Proceeding upon the hypothesis that a nut-gall ink was used by the transcriber, a dilute solution of ammonium sulphide was applied to the manuscript by means of a small sponge, with the hope that the faded iron compound would be transformed into sulphide of iron, which is black. The result was highly satisfactory; indeed, we were able to photograph the restored manuscript.

What *is* the Inferiority Complex?

By a Medical Correspondent.

The "Inferiority Complex" is often invoked nowadays as an explanation of our own or other people's shortcomings, but the precise meaning of the term is seldom fully realized by those who use it. This common disability is here presented in the light of recent work on the subject.

THE inferiority complex has become a catch-word, and since it is usually understood to mean a tendency to underrate ourselves, it is not surprising that so disarming a quality should make a strong popular appeal and be readily and widely claimed. But it is not quite in this sense or so simply that Dr. Adler uses the term which he invented, and, indeed, it is hardly likely on general grounds that a feeling of inferiority should arise spontaneously and persist without support.

It is true that the attitude of self-depreciation seems irrational and even perverse, but it becomes a little less mysterious when we examine the effect upon character of a real disability and discover that the effect is proportional, not to the degree of inferiority, but to the intensity with which it is resented.

This may be illustrated by the reactions to blindness and deafness. The character of the blind man is seldom much altered by his infirmity, while the deaf man, though his disability appears to be slighter, is liable to become irritable and suspicious. The blind man accepts his inferiority and has no hesitation in admitting it, but the deaf man is usually somewhat reluctant to disclose that he is even "a little hard of hearing," and is apt to attribute his difficulty to other people, who "won't speak clearly." We certainly cannot blame the deaf man, for it is a curious piece of injustice that the help and sympathy of society should be distributed so unequally between the blind and the deaf. But the deaf man is on the way to develop an inferiority complex when he is reluctant to admit his deafness, or tends to under-estimate it and to attribute to other people the inconvenience that it causes him. For if we resent an inferiority so much that we cannot bear to think about it, then our next step must be to push it away

into the background of our mind, to refuse to admit to ourselves its importance—perhaps even its existence. But this quite natural procedure does not abolish the feeling of inferiority, which continues to exist though without apparent justification; that is to say, an inferiority complex has been created. But it has been created not so much by an inferiority as by an intense resentment of inferiority, a trait that is not quite compatible with the humility implied in the popular conception of the inferiority complex.

Resentment.

The actual inferiority which we hate so much to think about that we bury it out of sight, is often relatively unimportant; it may be our social position, our personal appearance, or our lack of physical strength or some other shortcoming that we consider we ought not to mind and ought to be able to accept with reasonable acquiescence to the inevitable. So we tell ourselves that we do not feel strongly about this inferiority, whatever it may be, and we try to ignore it; but the resentment remains, and it is difficult to avoid the conclusion that this resentment of inferiority in general is the effective cause of the distortion of character. It may be so strong that it will, by itself, create a feeling of inferiority out of the mere falling short of perfection which every sane person must acknowledge in themselves and most are willing to accept.

It is not a simple matter to account for this intense resentment and intolerance of inferiority. Both Freud and Adler attribute it to an ideal self, which may set for us a standard of perfection from the height of which we look down upon our real self and condemn it as miserably inadequate. The word *ideal* does not here imply moral excellence, for the ideal self may be all-powerful, universally admired or wholly unscrupulous, and in a woman it may be masculine and in a man super-masculine. On the other hand, it contains what we call "conscience," and it is a normal and necessary part of the personality.

According to Freud the ideal self, or *super ego*, is created chiefly out of the child's conception of the parents or from day-dream substitutes for them. Adler is not quite so definite, and seems inclined to regard the ideal self, which he calls "the fictive goal of superiority," as primarily a reaction to man's awareness of his own weakness in comparison with the hostile forces of nature. It is a general reaction of mankind, which the child recapitulates in the process of growing up, and it is recognized also by Freud. The ideal self, linked through our parents with our remote ancestors and dominating our work-a-day personality, for good or ill, from the shadowy background of the personality, is an attractive and difficult subject. But it would lead us away from the inferiority complex, which, if our explanation of it is correct, now appears in the light of a superiority complex and, indeed, it is in this form that we are chiefly aware of it in other people.

The man who suffers from this complex lives with a vague feeling of inferiority for which he cannot satisfactorily account, since he feels, intuitively and correctly, that it is not adequately explained by any manifest disability. With the unattainable standard of the ideal ego in the background he feels his inferiority as strictly personal, as an inferiority of the very "I-myself." There are two lines along which he may deal with this uncomfortable feeling. The more normal way is to try to counter-balance it by single-minded concentration upon success; and the feeling of inferiority may be more or less stifled by the realization of personal ambition or, since "money answereth all things," by the accumulation of wealth. Although neither of these things may bring complete satisfaction to the individual, they are usually a benefit to society in general. The less normal way is to seek an antidote to unfavourable self-criticism in the approbation of others and by the exploitation of every occasion that may be used to enhance self-importance. If the inferiority complex acts along these lines it may compel a man to advertise his acquaintance with those who are great and distinguished, almost pathetically, as a reassuring testimonial of his worth, while at the same time he is compelled to belittle his fellow men in order to reduce them to his own level or beneath it.

Outward Pose.

If we can bring ourselves to imagine the diffident personality behind this uneasy self-aggrandisement we shall be able to feel at least more sympathetic towards a type that is superficially not very agreeable; we may even discover, as the intimate friends and biographers of Lord Curzon discovered, that this outward personality is in a way artificial and may conceal, all too effectively, a likeable human being.

The subject of the inferiority complex sometimes dreams that he is walking up a descending escalator in a gigantic underground railway station, and whether we believe in dream-symbolism or not, this is an apt simile for the task to which the dreamer is committed; neither in the dream nor in life can he reach the unseen top of the staircase and join hands there with his Ideal Ego.

The feeling of personal inferiority drives a man not

only to insecure heights of self-aggrandisement, but compels him to take elaborate precautions against failure. For he tends to see almost every situation in life as a test which will either expose his weakness or, happily, disprove it; and he uses, unconsciously, many shifts to escape without loss of self-esteem from situations that shake his confidence and from competition with his equals. He is too unworldly to engage in commerce, too shy to speak in public, too modest to submit his writings to a publisher or too idealistic to find a wife, and there is no end to the subtle evasions which the inferiority complex may require in order to safeguard the personality from failure. Such a man is over anxious about the future, often overworking in order to make his position doubly secure, and he dare not forget his work even at the end of his long day. Life becomes a difficult business and is apt to take on a hostile colouring, so that any avenue of escape from it may prove dangerously attractive. A physical illness is a temporary refuge that is sometimes hard to leave and, if the situation is desperate, neurotic symptoms may appear and justify a retreat from the battle.

Stammering.

The conflict between ambition and self-mistrust is often shown rather patently by the stammerer, who seems to provide his own excuse for failing to realize his ambitions. The writer remembers well a sufferer from this disability declaring, with the grinding emphasis of a bad stammer, "If it were not for this cursed affliction I should be one of the greatest orators —and revolutionaries—in England," and one could not help feeling that this eagle had clipped his own wings.

An example of a personality far more severely, and, indeed, disastrously dominated by the superiority-inferiority complex, may be found in the Russian novelist Gogol. Professor Lavrin* gives the following vivid and penetrating description of his character :— "As a youth he was restless, secretive, boasting, suspicious and touchy. Already at that age he was a bundle of contradictions, and such he remained all his life. Being small and ugly, he soon became extremely self-conscious. It is quite possible that from sheer self-protection he fostered his tendency to discover in things and people all that was bad, ridiculous and grotesque. This tendency he combined with a temperament and imagination completely romantic. Yet his mentality showed, above all, the negative features of a romantic type : uprootedness, fear and hatred of reality; a strong need to forget the world as it is; and an even stronger need to expose it, or to take revenge upon it by means of a protesting 'realism.'"

Of Gogol's last book Professor Lavrin says that ". . . it is a collection of high-faluting commonplaces about religion, morality, art and literature on the part of a man who forces himself to be a preacher, or even a new Messiah, for the ultimate benefit of Russia, if not of the whole world. . . . It marks the decline of Gogol's genius, and also of his sanity. At this period he was already haunted by the idea of death and hell."

But in order to observe the workings of this complex we need not go far afield, for although the type of character that we have already sketched is abnormal to the point of neurosis, yet we cannot stand aloof from it in wholly complacent superiority. We all begin our life in the relative inferiority of childhood, and the success with which we outgrow it and learn to accept the inferiorities that fall to our lot in later life, depends very largely upon our parents and upon our education. There can be few of us who have not cherished, at some time or other, the day-dream that we are far greater than circumstances allow us to appear. The popularity in melodrama of the chauffeur who turns out to be a Duke, of the despised clerk who is really the great detective incognito, and of the harmless old man whom only the reader knows to be the master-brain of the great criminal organization, seems to indicate the vitality of the myth of the hero in disguise, which has already provided us with Heracles in the house of Admetus, Siegfried the fosterling, Haroun al Raschid, Cinderella, and many other great ones who have stepped from obscurity to triumph. And we may reasonably suspect that the birthplace of these heroes is really in our super-ego, where they have remained imprisoned by implacable reality.

*" Russian Literature," (Benn's Sixpenny Library).

New Rail Route.

TILL the summer of 1928 Spain was joined by rail with France—and through France with the rest of the European continent—by only two lines, one along the Atlantic coast and the other along the Mediterranean, each winding its way between the mountains and the sea, in order to avoid the crossing of the lofty Pyrenees. This year, however, will see the two countries joined by four different through lines. The new line connecting Pau and Saragossa was inaugurated by H.M. Alfonso XIII and the French President. Fourteen tunnels have had to be bored through the mountains, and the most important of these, the Somport tunnel, is five miles in length.

The Bedford Modern School Museum.

By the Rev. P. G. Langdon, M.A., F.S.A.
Hon. Sec. for Bedfordshire, Society of Antiquaries.

Many readers interested in school and local museums should be encouraged by the example of Bedford Modern School, which within the past few years has developed what is now the finest museum in Bedfordshire. The exhibits are planned to illustrate the county history from discoveries made within its borders.

As is well known, the problem of our national museums and collections is at present being deliberated by a Royal Commission. Not the least urgency is to decide how the enormous selections of exhibits may best be used for the wider education of the people of this country. Scattered throughout the land are museums *and* museums—especially the latter !—and therefore there is need for reform and specialization. In a recent issue of *Discovery*, the need of an Imperial Ethnographic Museum was very ably noted.* What a tremendous aid such a museum would be, not merely for research into primitive customs but also for illustrative purposes in a study which is now entering some of our schools, namely, the history of religions. Many boys and girls to-day are wondering where lie the connexions between many points in primitive religions and their survivals in the Old Testament. Similarly the interest which has waxed strong in all parts of the world through the discoveries, not merely of the remains connected with prehistoric man, but with the bygone, almost visionary empires, has caused the youth at our schools to desire more tangible evidence, even of the history of their own immediate localities.

BEDFORD MODERN SCHOOL.
Many of the specimens have been presented to the museum by county residents and by former members of the School.

That such a result can be obtained, in spite of obstinate resistance, cynical criticisms, and the apparent poverty of possible valuable exhibits, is evinced by the state to-day of the Bedford Modern School museum at Bedford. This museum, which has been visited by many of our most notable antiquaries, and by people from all parts of the Empire, is the result of the persistency of aim of its present honorary curator. It was built and furnished simply in 1884 by the late Mr. Charles Prichard, in memory of his mother. The donor had a hobby—the study of minerals and fossils. He hoped to induce some of the boys of his old school to engage in this hobby also, and so he presented an interesting nucleus of specimens from all parts of the globe. Such a hobby, however, is not that of the ordinary boy to-day—he will have none of it, unless his future be that of a mining engineer. The original collection had little attraction for the average schoolboy. Until 1920 this school museum was little more than a depository for a very undignified lion of eccentric proportions, scores of pickled snakes, birds of dreadful contour and worse plumage, specimen cases of manufacturers' goods, shoes from all parts of the world, and so forth—in fact "junk," if such a word be permissible.

In 1919 the county of Bedfordshire possessed no museum of any sort. In April of that year, at the request of the Rev. H. Pollard, Rector of Millbrook, the Bedford Modern School Archaeological Society dug in the churchyard there to try to find reputed effigies from the church, and found them. They are now firmly fixed in the chancel of that church. This discovery so "enthused" the boys, that the president of their society decided to make the school museum one primarily for the benefit and interest of the school Archaeological Society. Bedfordshire ought to have had in existence one of the finest collections of local palaeolithic implements in the country, but both the county and the county town have, till within the last few years, been notoriously callous and careless about local

* "The Future of our National Collections." By E. N. Fallaize. November, 1928.

antiquities. The result has been that numerous interesting specimens are reposing in museums in counties far away from their original locality, or else lost to the public altogether.

Not a single specimen of its present magnificent collection of Bedfordshire antiquities did the School Museum possess in 1920. Then the late Mrs. Charles-Williamson of Kempston offered to let the school have her local collection of Roman and Saxon pots and jewellery, which had been on loan to the Charterhouse school museum for some forty years. That little collection had practically started the Charterhouse museum, and it certainly started that at Bedford on its present lines. The honorary curator definitely aimed at making the museum, not a repository for Bedford's white elephants as it was till he took charge in 1920, but illustrative, so far as it could be, of the history of man, especially in the county. Other important additions included a collection of Bedfordshire palaeolithic, neolithic, Roman, Saxon and natural history specimens from Mr. J. S. Elliott of Bewdley. This loan comprised a great part of the late Mr. Worthington Smith's collection of antiquities from the Dunstable neighbourhood.

Now came the difficulty of finance. A request for a few shillings to buy some blinds for the south end of the museum was turned down—not a very propitious start!—and perhaps it was not to be wondered at: the so-called museum hitherto would have disgraced a lumber room. However, the late Mr. John Draper, an old boy of the school, came to the curator's aid with £50 and, encouraged by other gifts, the curator approached the Bedford Town Council. They gave him leave to take on loan, or to reject, the specimens of broken pots and stone implements from the late Mr. James Wyatt's collection, which were lying thick in dust and spoiling with damp in a room beneath the Corn Exchange. What a nightmare those days of dirt and grime seem to one now! However, this article is not written for the glorification of the honorary curator, but to try to give heart to keepers of other school museums.

Through the Ages.

The aim of the placement of specimens in the Bedford Modern School museum is for visitors to be able, as it were, "to walk through the ages." The first central case on the right of entrance is therefore devoted to a magnificent selection of palaeolithic implements from the neighbourhood, because, so far at any rate, no eolithic implements have been identified with Bedfordshire. It will be recalled that in the middle of the last century, a doctor at Abbeville, M. Boucher de Perthes, succeeded in persuading the scientific world that what we now roughly term palaeolithic flint implements were not freaks of Nature, nor shaped by Nature as was previously supposed, but were the work of man. Among those who visited Abbeville and studied the sites at which M. Boucher de Perthes made his investigations, was the late Mr. James Wyatt, F.G.S., of Bedford. Wyatt then patiently watched the excavations at Biddenham, Bedfordshire, of some gravel pits which were carried to their base in 1861, and to his joy espied two excellent specimens of types of palaeoliths already known at Abbeville. It made a great stir at the time, both in France and England, and we are proud at the museum to have in our possession some of the specimens discovered by M. Boucher de Perthes and some of Wyatt's collection. But knowledge has advanced since those earlier days, and we can distinguish eight different types of palaeolithic implements from Kempston and Biddenham, places facing one another on the banks of the Great Ouse. The museum possesses several hundred specimens, some of which are magnificent.

Animal Remains.

Remains found in the local gravels, of the rhinoceros, hippopotamus, elephant, cave bear, red deer, etc., are to be seen in a wall case opposite the palaeolithic. The second central case is devoted to Neolithic implements, mostly those found in the Dunstable district by Worthington Smith. A collection amounting to several hundred specimens, some being pigmy examples, of neoliths from the neighbourhood of Honey Hills, Bedford, Oakley and Cardington arrived last November from Major Hynes, who has been searching the neighbourhood most carefully. The cases also contain a few good specimens from Turvey, Flitwick and Clapham of the transitional type of stone implement used in the Bronze Age. The third and fourth central cases contain Bronze Age skeletons from the Dunstable district, skeletons collected and drawn by Worthington Smith at the place of excavation. The three skeletons were assembled and set in the characteristic crouching burial attitude of their Age, by Mr. G. C. Dunning while still a boy of fifteen at school. Another wall case contains specimens of local Bronze Age urns and a fine beaker, some of the bronze hoard from Manor Farm, Wymington, and the only bronze lance head known to have been found in the neighbourhood of the County Town.

A magnificent series of Early Iron Age pots, from Kempston and Sandy, are also exhibited, almost as

perfect as the day on which they were made. An interesting little set, lately placed in the case, is that of the remains of a Celtic dwelling of the first century A.D., consisting of a hearth-stone completely burnt through, remains of three cooking pots, two broken triangular loom-weights, a spindle whorl, two pot boilers, and a large domestic vessel a foot high with thumbnail ornamentation. What tragedy did this little set once witness? A long wall case next houses a magnificent collection of Roman material from the site of the G.N.R. station at Sandy, and from Dunstable Downs, Maiden Bower, Kempston, Sandy, Totternhoe, Limbury, Kensworth and Campton, with several Saxon pots from Bedford, Biddenham and Kempston.

Saxon saucer brooches are shown in other cases, with a necklace of glass and amber beads, bosses of Saxon shields, spear-heads, swords, Anglian fibulae, also a notable Viking sword, and two Danish combs excavated within a hundred or so yards from the School itself. Another flat case contains specimens of Roman bronze coins of every emperor from Tiberius (A.D. 14-37) to the time of Theodosius (379-395) all found at Sandy, together with a case of silver coins of Aethelred II, Canute, Edward the Confessor, and William I, all of which were "minted" at Bedford. An adjoining case is filled with Norman and mediaeval pottery discovered when excavating in the High Street for shop foundations, and from the site of Cauldwell Priory.

A fine collection of Bedfordshire traders' tokens of the seventeenth century is near by, while another case is devoted to the fast disappearing industries of Bedfordshire—lace making and straw plaiting. The lace making is supposed to date back to the incursion of the Huguenots into the county between

CELTIC REMAINS OF THE FIRST CENTURY, A.D.

This exhibit illustrates an early Celtic home, as follows:—(1) Two pot boilers; (2) spindle whorl; (3) triangular loom weight; (4) burnt hearth stone; (5) fragments of cooking pot; (6) pot one foot high with thumbnail ornamentation.

INTERIOR OF THE MUSEUM.

The curator's plan has been to enable visitors "to walk through the ages," hence the cases of specimens are arranged chronologically.

1568 and 1668. Displayed to full advantage is a three-legged stool in which three inverted and water-filled globes, termed "flashes," are held on short wooden cups; these were used as aids in focussing beams of light from a candle on to three lace workers' pillows. On the wall near by are three straw mills. The fast-disappearing hand tools of agriculture are displayed on the wall and floor. A large wooden plough in use some sixty years ago; flail, barley-awners, chads, iron dibbers, false links for broken chains, horse docking shears, eel greaves, a couple of man-traps, ancient draining tools—all help to make the present generation see the benefits initiated by the Industrial Revolution and by feelings of humanity. A set of bygone rush-cutting instruments and tools used at Pavenham for making rush mats, carpets and bags, is promised, also a set of farm ale-brewing utensils.

It will thus be seen that a very concise collection of great educational value has been assembled in the County Town at one of its two famous boys' schools. Every boy or even adult may not be interested at first in all these exhibits, but there are also some miscellaneous specimens of interest, such as birds from Australia, New Zealand and Brazil, Chinese porcelain, and objects from Ancient Egypt. The master of an elementary school some fourteen miles from Bedford told the writer that the children there will save up their pocket-money for weeks to have the joy of coming to Bedford by bus to visit the museum. In order to show their appreciation they presented the treasure from their little school museum, a piece of fossil wood about a foot long which was dug up in their own village. The museum is open to the public during term on Wednesday and Saturday afternoons, and to any school at any time by arrangement.

Photography in the Infra-Red

By J. F. Corrigan, M.Sc., A.I.C.

Photographs made with the dark rays of the spectrum have unusual characteristics. Distant views stand out with remarkable clearness, and the method has valuable possibilities for the photography of architectural subjects. Paintings also may be analysed for detail.

THE subject of the "infra-red rays" is a popular one at the present time. No doubt its newly acquired fame is to a large extent due to the publicity given to the Baird system of "noctovision," by means of which a face or some suitable object may be televised, despite the fact that the object so observed is actually placed in darkness. Then again, the mythical "death rays" have inevitably come to be associated in some minds with the dark portion of the spectrum, and thus it is that the infra-red rays now carry a popularity which they hardly deserve. Certain aspects and properties of the rays are, however, of more practical application, and it is here proposed to describe an unusual method of recording objects, which can be undertaken by anyone possessing a reasonably efficient camera and lens. Although infra-red photography is no new subject, it has hitherto been necessary to use special materials which may now be dispensed with, as will be described later.

One of the most famous photographic investigators of the last century, Captain Abney, described methods of preparing plate emulsions sensitive to infra-red rays as far back as 1880. Abney's experiments, however, did not receive any great measure of attention. In 1910, Professor R. W. Wood, of John Hopkins University, U.S.A., published a number of remarkable photographs which he had succeeded in taking by means of the infra-red rays alone. They depicted summer landscapes, and practically for the first time the peculiar and almost fantastic characteristics of a true infra-red photograph were made known to the public.

NORMAL PHOTOGRAPH.
Country lane taken on a sunny day.

During the Great War some little work was done on the subject, particularly in the United States, and at still later periods similar investigations have proceeded at research establishments in this country. In all such instances, or, at least, in the majority of them, specially sensitized plates have been employed, such plates being bathed in solutions of certain photographic dyes, notably dicyanine, neocyanine, and kryptocyanine. Careful treatment of a photographic plate with solutions of these dyestuffs confers an extreme infra-red sensitivity upon the emulsion.

It does not appear to be known generally, however, that the modern panchromatic plate possesses quite an appreciable degree of infra-red sensitivity. With a suitable infra-red light-filter, therefore, any number of infra-red photographs can be prepared during the bright days of the summer. The experiments of the writer have been conducted solely with Wellington Spectrum panchromatic plates of an H. & D. Speed, 450. With these plates a fully exposed infra-red picture of a landscape or distant scene may be taken on a bright sunny day with an exposure of from fifty to sixty seconds, the lens aperture being of the order of f/6.3. The very recent introduction of the new "soft" panchromatic emulsions, having a daylight speed of 750-800 H. & D., enables the above exposures to be lowered by two-thirds, and thus brings the subject of infra-red photography within very practical bounds.

After focussing the scene to be photographed, it is necessary, of course, to equip the lens with a

specially prepared filter in order to cut out all the visible rays of the spectrum. While an infra-red filter of sorts may be improvized by combining a piece of blue glass and a dark ruby glass, and by placing these in front of the lens, nevertheless, the infra-red transmitting efficiency of this combination is poor, to say nothing of the optical distortion which is created by the glasses. Carefully prepared infra-red filters, however, may now be purchased for a few shillings, either in the form of a gelatine film to be placed between the lens combinations, or cemented between optically worked glasses to push or screw in front of the lens. Such filters are perfectly stable, and do not deteriorate with keeping.

The most striking infra-red pictures are those which are made on bright sunny days. A clear blue sky should be present, and, in order to prevent the appearance of movement in the photograph, wind should be at a minimum. These conditions are often most favourably attained during the early evening of a summer's day. Having focussed the picture, the infra-red filter should be placed in position on the lens, and the exposure made. It is always advisable, also, to make a "control" negative of the scene upon an ordinary plate, without, of course, the use of the filter. Development of the infra-red plate and of the normally-exposed "control" plate should proceed in a perfectly normal manner, after which the two negatives may either be printed by contact, or enlarged.

Such, in brief, is the technique of infra-red landscape photography, using ordinary panchromatic plates for the purpose. The exposures necessary even on sunny days are, of course, fairly lengthy, being of the order of from fifty to sixty seconds for medium-speed panchromatic plates, as stated above, and at a lens aperture of approximately f/6.3.

If it is desired to reduce the degree of exposure necessary for the production of infra-red photographs, specially-treated plates will be found essential. Plates treated with the infra-red sensitizing dyestuff, *Kryptocyanine*, can now be obtained from the Kodak Company. They usually required bathing in a weak ammonia solution before use, and are said to give fully exposed infra-red negatives with half-a-second's exposure. On the other hand, a satisfactory infra-red sensitizing bath can be made up according to the following formula :—Water 50 cc., alcohol (rectified spirit) 50 cc., ammonia (.920) 2 cc., alcoholic soln. dicyanine (1 : 1,000) 2 cc. Ordinary non-colour sensitive plates of medium-speed should be bathed in the above bath (in complete darkness) for three minutes. Afterwards they should be allowed to dry in the dark, and used within four or five days of their preparation. Plates treated in this manner will reduce the necessary infra-red exposure under the conditions described above to approximately three or four seconds, and, under some conditions, to almost one second. Generally speaking, however, perfect infra-red photographs can be obtained by the employment of ordinary commercial panchromatic plates, provided the necessary somewhat lengthy exposure can be given.

NOT A SNOW PICTURE !

The same lane, photographed in the infra-red.

Photographs of landscapes taken by means of the infra-red rays alone are very characteristic in their nature, as will be evident from an examination of the accompanying photographs. Owing to the fact that fresh green foliage acts as a strong reflector of the infra-red rays, leaves and trees appear in the photograph as if they had been covered with a layer of freshly-fallen snow. Even the leaves of the copper beech tree reflect the infra-red rays, thus recording themselves in the picture in almost pure white.

A peculiar feature of all infra-red photographs made in sunlight is the enormous depth of the shadows and the total lack of detail which they show. Owing to the fact that the infra-red rays are not diffused and scattered by atmospheric moisture, distant views stand out with remarkable clearness, and, indeed, it is likely that this fact may bring about a practical application of this branch of photography in future.

Portraits taken in the infra-red are interesting novelties. The face of the sitter appears in the photograph of a corpse-like hue, whilst blue or grey-blue eyes come out as small circles of black, and are, of course, perfectly expressionless. Any lines or creases present in the face are enormously exaggerated, owing to the shadows which they create.

In conclusion, it may be stated that the above experiments represent merely a few in the sphere of infra-red photography. It should not be imagined that infra-red photography constitutes a field of work which is suitable only for bright summer days. On the contrary much interesting work in this direction can be carried out even on the dullest of days, provided always that the requisite exposure can be given to the plate.

The photographic recording of minute architectural detail from a uniformly lit surface is a branch of practical importance which has hardly been attempted. Paintings may be found to show unsuspected details and markings when photographed in the infra-red, whilst old and badly-stained prints and engravings appear spotlessly white when photographed through an infra-red filter.

Reflections on a "Silica Garden."

By Patrick Heffernan, M.D.

A silica garden may be "grown" from a few crystals and affords an amusing experiment. Silicon occupies a position in chemistry comparable with that of carbon in the realm of biology. Carbon is the symbol, so to speak, of organic life, but the writer suggests that its rival may play a part of no less significance.

SILICA (SiO_2, *silicon dioxide*) is a curious substance. Mighty in its past, of enormous but inert bulk in the present, it appears at first sight to enter but little into the life that has been established on our planet. It is not inimical to life, like antimony, arsenic or lead, but rather it gives the impression of a gigantic potentiality, with a great organic future—behind it.

In the region of folk-lore—regarded as it is by many as a mere land of superstitious fancy, but by others as a storehouse of atavistic memory awaiting interpretation—silica holds an unique place among minerals. Is not the opal, which is built of silica, the most unlucky of stones? Does it not change colour when ill health or misfortune threatens its wearer? It was Nonius's opal ring that Anthony coveted for Cleopatra. "The delicate colours and tendernesses of the opal," wrote Onomacritus the Greek, "remind me of a loving and beautiful child." But the opals of Lightning Ridge, while giving a play of rainbow colours by reflected light, become jet black when viewed by transmitted light, as if resenting such intrusion into their privacy.

The "Jewel in the Lotus" is an opal. In that hair-raising tale, "The Barbalangs of Cagayan Sulu," Commander R. T. Gould tells us of a stranger opal still. He quotes an article from the Journal of the Asiatic Society of Bengal, 1896, according to which the Barbalangs are ghouls or vampires whose astral bodies, in the guise of blood-sucking insects, are capable of attacking living human beings. The only effective charm against these attacks is "the coco-nut pearl, a stone like an opal sometimes found in the coco-nut," which "is only of value to its finder as its magic powers cease when it is given away. When the finder dies, the pearl loses its lustre and becomes dead." Plant physiology and biochemistry now teach us that the jewel in the lotus and the coco-nut pearl, although products of organic life, are true opals. That is to say, they consist of partly hydrated silica, and hover between a crystal and a "gel" at the point of junction of two different states of physical existence, the "colloid" and the "crystalloid." At that point we seem to be close to the threshold of life. At that point, silica seems to exhibit a weird form of life of its own, that mocks and caricatures organic life as we know it.

In the opinion of Professor Collis, there are reasons for believing that all through the geological ages, silicon and carbon have, so to speak, struggled for supremacy. Especially when the first faint stirrings of life began to appear upon the planet, a long-drawn struggle took place between the two elements for the control of the organic world, and the predominant partnership in living matter. The issue hung in the balance for a time, but carbon eventually won. We still find the older element, however, retaining its grip on some of the lower forms of life. In the stiff stems and cutting edges of the bamboos, sedges and grasses, in the tissues of water plants, in the pericarp of grain, in the skeletons of the equisetums, silica is an essential constituent. In the animal kingdom it is found in the infusoria and sponges, in the feathers of birds,

and to a small extent in the organs and connective tissues of all living animals. But it has long since yielded pride of place to carbon, and even to calcium, in the constitution of living organisms. In the struggle silica has been forced back, like an aboriginal race before waves of invasion, to its mountain fastnesses, where it remains segregated and apart from the main stream of organic evolution.

Sometimes, however, as if in mockery of its successful rival, it imitates or caricatures organic life in a peculiar way of its own—and so successfully that even the expert may be deceived. Artificial plants, consisting of hydrated silica and similar colloids, may be grown, which have the appearance of real life. "They possess the cellular structure of living matter, they reproduce such functions as the absorption of food, the excretion of waste products, and they may possess movement and growth like organic cells."

Dr. Mellor, in his "Modern Inorganic Chemistry," gives the following instructions for the cultivation of a "silica garden." "A beaker or bottle is filled with sodium silicate, specific gravity 1.1, and crystals of, say, cobalt nitrate, cadmium nitrate, copper sulphate, ferrous sulphate, nickel sulphate, manganese sulphate, zinc sulphate, etc., are allowed to fall into the beaker so as to rest on different parts of the bottom. The whole is allowed to stand, overnight, in a quiet place, when plant-like shoots appear to grow from the crystals. The stalks and fronds have a form and colour characteristic of the metal salt used as 'seed.'"

Like the Lily of Malud, they "climb in an hour, a ghost like a flower or a flower like a queen." Dr. Mellor tells us that the phenomenon is an effect of "osmosis." Similar plant-like growths can be obtained by using other solutions, for example, a granule of copper sulphate and sugar in a solution of potassium ferrocyanide and gelatine, and, we read, "the growths are, of course, no more related to real plants than a living man is related to his statue."

What is Life?

In the classical story, however—the "fairy tale"—Galatea came to life, and with all respect to the famous chemist, the relationship between the "silica garden" and the living garden may be closer than he will allow. One might stress the fact, for example, that the silica garden and the living garden have one important point in common, that they are both examples of colloidal phenomena. How far "vital" phenomena may be explained on a basis of colloidal physical-chemistry is a fascinating problem. It is conceded that many "vital" reactions, formerly regarded as specific to living cells or their products, are inter-colloidal in nature, and, on the other hand, many physiological processes formerly regarded as "chemical" in nature, belong rather to the region of colloidal physics. The gulf between the silica garden and the living garden appears to be narrowing.

This brings us to a remarkable man and a strange episode, for the story of which we are again indebted to Commander Gould and his famous book, "Oddities." In the year 1836 Mr. Andrew Cross, a Somerset country gentleman and an enthusiastic experimentalist, got into serious social trouble through experimenting with silica. His experiments were regarded as impious and irreligious, because—so it was said—he attempted to produce "life" from dead matter.

An Early Experiment.

Cross mixed solutions of potassium silicate and hydrochloric acid (thereby producing hydrated silica sol, or "silicic acid"), and allowed the mixture to seep into a porous piece of lava which formed part of an electric circuit. In other words, he attempted an experiment in electro-endosmosis. He hoped to produce quartz crystals. He produced, of all things in the world, mites! Little bud-like growths formed on the surface of the lava, they increased in size, sprouted out filaments which thickened into limbs, became detached, and swam away! It will probably never now be settled whether these mites were osmotic artefacts—a zoological "silica garden" to set over against Dr. Mellor's botanical silica garden—or whether they were living mites from accidental contamination of his materials. We have no knowledge of any confirmation of his results by subsequent experimentors, and it might be difficult to reproduce the conditions with exactness. There the matter rests.

The writer has endeavoured to suggest that silica has dropped out of the picture of life on this earth, in which its rival, carbon, occupies so prominent a place. But if we allow our imaginations to wander further afield, and postulate, for the sake of argument, the not impossible presence of life in other worlds, we cannot shut our eyes to the possibility of silicon "taking the part" therein, that carbon does with us, and we may spend an amusing evening in extrapolating from our knowledge of carbonaceous life on this earth the possible conditions of such siliceous organic life elsewhere. It seems that some writers of fiction have already made the attempt.

Is it outside the bounds of possibility, in this world of ours, that at some future epoch carbonaceous existence may be no longer possible, and that silicon may take over the torch as it drops from the palsied hand of its successful rival?

Book Reviews.

William Wordsworth: His Life, Works, and Influence. By GEORGE MCLEAN HARPER, Professor of English Literature, Princeton University. Revised edition. (John Murray. 16s.).

Anthologies are of two kinds, those which group their material by subjects and those collecting it in relation to date. In volumes of poetry the former arrangement has hitherto been more in evidence, but owing to many new researches on the lives of the poets, the practice is growing of studying their work in the light of the conditions under which it was written. Because Wordsworth wrote many verses of public and national interest, as well as poems about nature, he is probably the most popular of the English Romanticists, and is certainly more often quoted than Keats or Shelley. It is not, however, generally realized that there was a definite break in Wordsworth's life, and that in his youth he was an ardent advocate of the doctrines associated with the French Revolution, which in his later years he was at such pains to disown.

No biographer had discovered this demarkation so clearly before Professor Harper published in 1916 his two volume "Life," which has now been revised in one volume and brought up to date. The price is remarkably low and its six hundred pages include many illustrations. Previous writers had not unnaturally emphasized the later poems of Wordsworth, since more material exists relating to his old age and he was still remembered by many people living at the beginning of this century. While clearly favouring the ideas which inspired Wordsworth's boyhood and lamenting his retreat, Professor Harper nevertheless records the second phase with equal sympathy and understanding. But his enthusiasm is more marked during the opening story, and few scholars have done more to reveal new facts which show the poet's youth in true perspective. From the general reader's standpoint the revised edition under review has the advantage of being shorter; and it describes two discoveries of outstanding interest made during the past twelve years.

The first of these, due to Professor Emile Legouis, reveals that during his first visit to France Wordsworth fell deeply in love with Annette Vallon of Blois, by whom a daughter was born to him. From the many letters which passed between them, there seems no doubt that Wordsworth intended to return and make her his lawful wife, but Professor Harper points out that the laws in France were at that time in a great state of confusion, owing to the struggle between the Government and Church. Possibly also objections to a marriage were advanced by relatives on both sides. However that may be, his attachment to Annette undoubtedly influenced the young poet in favour of the Revolution, and in this connexion the further startling discovery has been made that probably Wordsworth returned to Paris during the Reign of Terror, in the autumn of 1793.

His conscience and his affections drove him to respond to the touching appeals of Annette, and he may have still entertained the fond hope of adding his efforts to those of the moderate Revolutionists and thus helping to save the cause from the extremists. The war between England and the French Republic had begun, and though communications between the two countries were not yet closed, a courageous act must have been required. Wordsworth is known to have been staying at Portsmouth during the late summer with a rich and generous friend named William Calvert, and although he made an excursion to the Wye Valley, he may have returned to Portsmouth, thence crossing to France with money provided by Calvert. He arrived in Paris to find the political situation much worse than nine months before, and finding that he faced almost inevitable death by remaining there, and being unable to reach Blois, Wordsworth must have returned, baffled in his bold adventure. He would, however, have witnessed the horrid spectacle of the execution of one of the Girondist deputies, Gorsas, on 7th October, and certainly the lines from "The Prelude" describing the nightly fears from which he suffered long afterwards, seem more likely to have been inspired by such an experience rather than by the conditions of his visit a year before:—

> . . . all things have second birth;
> The earthquake is not satisfied at once;
> And in this way I wrought upon myself,
> Until I seemed to hear a voice that cried
> To the whole city, "Sleep no more." . . .
> The place, all hushed and silent as it was,
> Appeared unfit for the repose of night,
> Defenceless as a wood where tigers roam.

The main positive evidence that a visit to Paris occurred is a statement in Thomas Carlyle's Reminiscences, that in 1840 Wordsworth told him he had witnessed the execution of Gorsas. Negative evidence is the absence of any record to show that Wordsworth was in England or Wales in the autumn of 1793.

Professor Harper wisely minimizes the unhappy incidents relating to Annette, but not improbably the remorseful memories of this early attachment may have influenced Wordsworth in his later denunciation of the French Revolution. However, his unique position as interpreting through personal experience one of the most tremendous political changes in history has only begun to be recognized. No writer has done more to make this position clear than Professor Harper, whose biography will always remain an outstanding tribute of American scholarship to one of the greatest English poets.

Chivalry: Its Historical Significance and Civilizing Influence, By Members of King's College, London. History of Civilization Series. (Kegan Paul. 15s.).

On the whole these lectures by members of King's College staff justify the editorial decision that chivalry is a subject which merits a volume to itself in a series dealing with the history of civilization. It might perhaps be thought that its importance was not sufficient to warrant more than its inclusion as one aspect of some larger question of mediaeval history. By taking into account the literature to which the institution of knighthood gave rise, the authors are able to show that its influence on the culture and mental habit of a great part of western Europe has been considerable.

Throughout English literature from Chaucer to modern times, the ideals of chivalry have constantly been held up as the standard of conduct. Truthfulness, honour, "playing the game" and consideration for others, were enjoined upon the members of knightly orders, as rigidly in theory as they are laid down in the code of the public school. Professor Reed, who deals in the final lecture with "chivalry and the idea of a gentleman," might perhaps have emphasized this point by touching upon the other side of the picture by a more extended reference to other and different ideals of some Tudor and early Stuart books of behaviour. It is also open to argument how far

the ideals of chivalry did survive in modern Germany, where he thinks they may have had even greater influence than in this country. It is possible, however, to regard certain characteristics as feudal and perhaps even tribal rather than as relics of the order of chivalry.

The Knighthood of England, France, Germany, Spain and Portugal, is each described in a separate chapter by a specialist in sufficient detail to give the reader some idea of the distinctive character of chivalry in each country. Notwithstanding the risk of discrimination, a special word of praise is due to the introductory chapter by Professor F. J. C. Hearnshaw, which brings out, not only the wide discrepancy between theory and practice in the order of knighthood, but shows very clearly how the ideal of chivalry was inconsistent with itself in trying to combine the three elements of religion, prowess in war, and devotion to gallantry.

When so many different authors deal with different aspects of one subject, some inconsistencies and discrepancies are inevitable. The general reader, for whom the book is intended, may feel puzzled to find in one chapter France described as the natural country of origin of chivalry as peculiarly adapted to the temperament of the Celt, when in the next it is ascribed to the Germanic tribes who had settled in France and then again to the Norman culture impinging on Latin institutions. These statements are not necessarily irreconcilable, but a more precise definition is needed to make the meaning clear in each case.

The illustrations, which are as nearly as possible contemporary, are delightful and have been chosen with care and judgment.

The Nappe Theory in the Alps. By FRANZ HERITSCH. Translated by P. G. H. BOSWELL. (Methuen. 14*s*.).

The Alps form part of that great world-wide mountain system that was built up in comparatively recent geological periods. Hence, complexities though there are to puzzle the minds of geologists for decades to come, the main features of this system, exposed here in a well studied area, present some of the best evidence for an explanation of the process of mountain-building. The complicated geological structures exhibited in this region have provided evidence for many theories in the past; but it is only comparatively recently that the stupendous forces involved in the building up of mountains have been realized and the Nappe Theory brought forward to explain the movement of large masses of rocks for scores of miles by the piling up of over-folded rock masses from south to north.

Though ranging himself amongst the opponents of the theory, the author does not neglect to give the evidence both for and against it; but at the same time he points out that "many syntheses of Alpine structure offered by the Nappe theorists lack a just appreciation of the arguments used by their opponents." Opponents of the East Alpine School of geologists may remark with Jenny that "the antagonism to the Nappe Theory is now more a question of prestige," but, as the author points out, their criticism has prevented scientific hypothesis from becoming dogma.

This translation from the German of a work by an Austrian opponent of the Nappe Theory of mountain structure, particularly as it is applied to the great European Alpine chain, brings the views of another participant in the present clash of conflicting opinions within easy reach of all students. It covers the tectonics of both the Western and Eastern Alps, and the list of references is in itself a useful guide to a study of Alpine structure.

Hans Staden. The True History of His Captivity, 1557. Translated and Edited by MALCOLM LETTS. *The Broadway Travellers Series.* (Routledge. 10*s*. 6*d*.).

The chief service which Mr. Malcolm Letts has rendered in giving us a new translation of Hans Staden's book, is the incorporation in it of a remarkable series of woodcuts which appeared in the first edition which was printed in Marburg in 1557. For some reason or other there were omitted from the edition issued by the Hakluyt Society in 1874 with an Introduction and Notes by Sir Richard Burton. That they should have been is curious, for if not quite up to the standard of mid-sixteenth century work in general, they must have been executed under Hans Staden's personal supervision—he figures in nearly all of them—and they do everything to adorn his text. Hans Staden was born at Homberg, and his life was comparatively uneventful until his second voyage to the New World and his captivity among the Tupi Indians of Brazil. It is with his experiences upon this second venture, when he joined a band of treasure-seekers full of the conquest of Peru and the promise of untold wealth, that the narrative before us deals.

The expedition was unfortunate from the first. The fleet, consisting of three ships, set sail at Easter 1549. Severe weather, however, soon separated them. Staden, after being at sea six months and narrowly escaping destruction off the rocky coast of Paranagua, eventually arrived first, and was found by his companions in the second ship some three months later. The third vessel was lost. After many vicissitudes, which we have no space to follow, he found himself at San Vincente, an island, on which the city and seaport of Santos now stands, engaged as a gunner at a good salary, and, with the promise of royal favours, put in charge of another island, Santa Amaro, and a fort on the mainland someway to the east. It was while he was here, and one day out hunting, that he fell into the hands of the very enemies whom he was supposed to resist. His account which follows is both moving and exciting. Staden was a pious Lutheran and he needed all his faith. Plunged into a hotbed of cannibalism, the gruesome details of their savage rites must be among the most complete and authentic records which we have. Miraculously preserved through the terror of his unknown God, which he managed to instil into them, and by making the most of his opportunities as a medicine-man and interpreter of dreams, he became among them an honoured guest, and when he succeeded in escaping after nearly a year, it was, on the part of his captors, amidst expressions of lamentation and regret.

If Hans Staden's book only consisted of his day to day experiences, it would have been worth the care upon it which has been bestowed; but in Part II we are given "a True and Brief Account of all I learnt concerning the trade and manners of the Tuppin Inbas, whose captive I was" and therein, and, in the case of the present edition, in the illustrations, its value lies. Indeed, it would seem a pity that the present translator has denied us in its proper place the original title page in full. "The True History and Description of a Country of Savages, a Naked and Terrible People, Eaters of Men's Flesh, who dwell in the New World called America, being wholly unknown in Hesse both before and after Christ's birth until two years ago, when Hans Staden of Homberg in Hesse took Personal Knowledge of Them and now presents His Story in Print." Good as the illustrations are, one of them need not have been reproduced twice.

Practical Colour Photography. By E. J. WALL. (Chapman & Hall. 15*s.*).

The recent progress in the various processes of colour-photography, especially in those where a dye image is transferred to a gelatine film, and the increased use of colour in cinematograph films justifies an enlarged and revised edition of this book six years after its first publication.

The omission of practically all historical and theoretical data does not detract from its value to the amateur in this artistic branch of photography. The introductory chapters give a brief account of colour formation, exposures, sensitive plates, colour filters and other apparatus. The remainder describes the actual processes in the various methods, old and new, by which colour can be introduced into photographic work with varying degrees of success. The recent developments in three-colour lantern slides and also in photomicrography and cinematography in colours are also described, with directions for the amateur to follow.

Through the Apennines and the Lands of the Abruzzi. By ESTELLA CANZIANI. (Heffer. 25*s.*).

In the remoter regions of the Apennines, far from the beaten track of native and foreign tourist, quaint and primitive beliefs and customs, which have long been abandoned nearer the larger centres of civilization, still linger on, an essential background to the peasant life of the neighbourhood. It was as artist and observer of the peasant folk of these areas and of their customs that the author of this volume toured the mountainous districts surrounding Aquila. In a land where foreigners are almost unknown, and the inhabitants are naturally suspicious, her task was not an easy one, but with the help of the local priests accommodation and means of transport were always available. Through her work as an artist she was brought into intimate association with many who narrated in great detail the local folktales, customs and religious superstitions.

The opportunity of collecting such information first-hand rapidly declines with the passage of the years in even such isolated districts as the " Lands of the Abruzzi " ; so that this well-produced volume and its contents are a welcome addition to both our library and our knowledge of local traditions.

Automaton or The Future of the Mechanical Man. By H. STAFFORD HATFIELD. (Kegan Paul. 2*s.* 6*d.*).

The author tells us that " an automaton, by analogy with the human model, should consist of three parts : limbs to work with, senses to perceive what it is working with, or what result it is producing, and a brain to regulate the action of its limbs in accordance with the perceptions of its senses." He then continues : " We are striving to create . . . thousands of different automata each specialized for a certain task." Whether these latter can be classed as mechanical men is certainly open to doubt ; the main portion of the book, however, is taken up with the progress and future fantastic possibilities in automatic and labour saving appliances.

Again : " Humanitarians . . . should seriously consider the employment of their resources on behalf of, and not against, the automaton . . . The idea . . . that the first function of industry is to find employment for the masses, must be abolished in favour of the endeavour to make it supply our needs with the minimum of labour." Without being unduly conservative, we must point out that the drudgery in attending endless automatic inventions often defeats their labour saving aims ; and we disagree entirely that large combines are a " hindrance to the progress of invention." We cannot, however, connect the plan for the simplification of English proposed by Mr. C. K. Ogden with either a successful universal language or typist automaton, but we admit that many ideas in this book are certainly a result of research.

The Outline of Man's Knowledge. By CLEMENT WOOD. (Richards Press. 8*s.* 6*d.*).

It is no easy task to condense the details of the history of the human race and of all the branches of human endeavour within five hundred and fifty octavo pages of type ; yet the author has, on the whole, made a good selection of the available material in this book, intended, as it is, " not only for those who have not had leisure for much reading, but also for those who are already provided with a good background of general knowledge." The first part, the outline of history, refers to the landmarks in the history of mankind onwards from the earliest dawn of civilization. The record is rather arbitrarily divided in the orthodox manner under the three headings of the Coming of Civilization, the Halting of Civilization, and the Reawakening of Civilization. However, as practically one-third of the book is devoted to an outline of science, which is not inconsistent with its importance in modern life, perhaps it must be granted that the increased material prosperity and individual liberty in the nineteenth century warrants the assumption that the French Revolution marks the reawakening of civilization.

The history of man's efforts in the realms of science, literature, art, religion and philosophy fill the remaining five parts of the book ; and there are not many important achievements or movements which have not a sentence to their credit. Elaboration of detail in such a volume is not to be expected or desired, yet it is surprising to find that the Great War is dismissed in a shorter space than that accorded to the history of the Mormon Church. Again, the whole subject of geology, on which the continued prosperity of modern civilization is dependent, based as it is on the supply of coal and oil, is summarized in one-tenth of the space devoted to a survey of American literature.

By no means the least useful feature of the work is the chronological index at the end, where the chief events recorded under the various sections are tabulated side by side, so that the progress of the arts and sciences are easily shown in their relation both to one another and the march of history.

Six Talks on Heredity. By MARY ADAMS. (Heffer. 2*s.*).

It cannot have been an easy task to compose popular short broadcast talks on such a subject as heredity, yet listeners must have been agreeably surprised to hear the elements of the subject so simply explained without the aid of the diagrams that their publication in book-form has allowed. In the author's own words : " There was nothing new or striking in the substance of these talks. Yet I found, from the correspondence I received, that the ideas they contained were novel, and even perplexing, to many who heard them." A small section of the public continually agitate for the substitution of jazz for educational talks in the broadcast programmes. The standard and the appreciation which resulted in the publication of these talks is sufficient argument, not only for their retention, but also for their extension.

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